JPRS-CEN-91-003
20 FEBRUARY 1991

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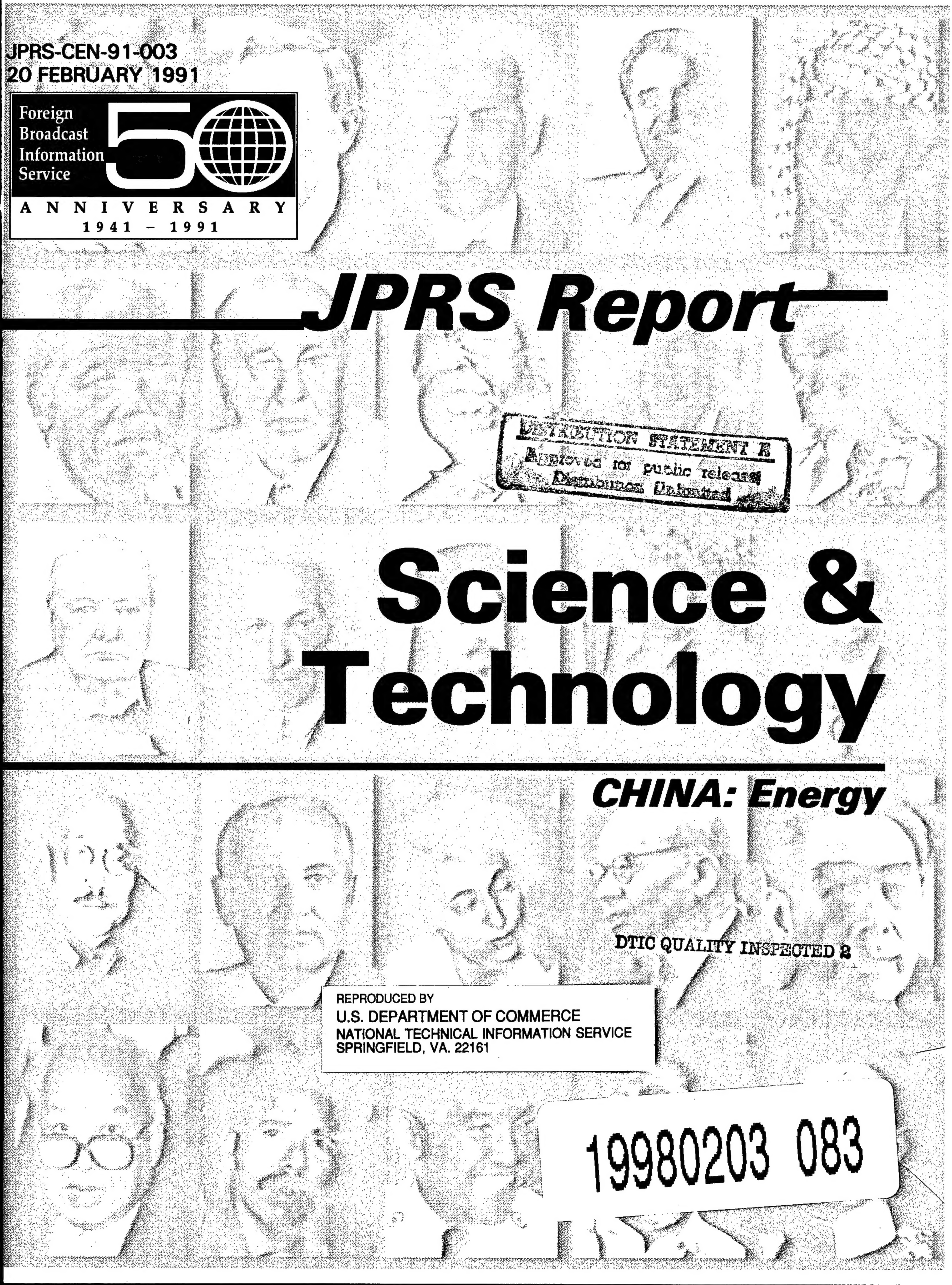

JPRS Report

Science & Technology

CHINA: Energy

FBIS 50th Anniversary Note

To Our Consumers:

This year the Foreign Broadcast Information Service observes its 50th anniversary.

The service, first called the Foreign Broadcast Monitoring Service, was established in 1941 prior to the U.S. entry into World War II. At the time, a number of U.S. Government officials were concerned about the content of foreign radio broadcasts—a relatively new means of conveying information and propaganda across borders. On their advice, President Franklin D. Roosevelt in late February 1941 allotted money from his emergency fund to institute the recording, translating, transcribing, and analyzing of selected foreign broadcasts for the U.S. Government. During World War II the service demonstrated that monitoring was a fast, economical, and reliable way to follow overseas developments.

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We members of the current staff of FBIS extend our thanks to consumers for their interest in FBIS products. To past staffers we extend our thanks for helping the service reach this anniversary year. At the same time, we pledge our continued commitment to providing a useful information service.

R W Manners

R. W. Manners
Director
Foreign Broadcast Information Service

Science & Technology
China: Energy

JPRS-CEN-91-003 | 20 February 1991

CONTENTS

Meeting Lays Down 5-Year Plan for Energy Sector

40200027c Beijing CHINA DAILY (Economics and Business) in English 7 Jan 91 p 2

[Article by staff reporter Huang Xiang]

[Text] The nation's leading energy officials and experts, buoyed by the promise of government backing, met in Beijing on Saturday to hammer out the industry's development plan up to 1995.

They are here attending the six-day annual national energy conference at which production targets are to be set, ways to raise efficiency finalized and more government finance considered, CHINA DAILY learned yesterday.

The conference heard that the Ministry of Energy Resources had called for annual production of 1.26 billion tons of coal, 155 million tons of crude oil, 20 billion cubic metres of natural gas and 870 billion kilowatt hours of electricity by the end of the five-year plan period.

"The targets are set in line with the government's planned economic growth during the Eighth 5-Year Plan period (1991-95)", said Wang Wenze, the ministry's spokesman.

Wang said top government officials had promised to keep the development of the industry on their priority list. Special funds would be set up for the coal, electricity and oil industries, he added.

To meet the target, Wang said, capacity to produce an extra 280 million tons of coal and 100 million kilowatts of electricity should be built during the five years. And capacity to produce an additional 110 million tons of coal and 57.3 billion kilowatts of electricity should be put into operation before 1995.

Also finalized at the meeting were the industry's production, investment, and construction targets for 1991.

Coal output was set at 1.11 billion tons, 50 million tons more than the target for 1990, Wang said, while crude oil production was required to reach 139.3 million tons, compared with 138 million tons for the previous year. The electricity output goal was set at 645 billion kilowatt hours, an increase of 40 billion on 1990.

Technical innovation should also result in the saving of energy equivalent to 10 million tons of standard coal, Wang said.

He said total investment in the energy industry for 1991 would be more than 70 billion yuan ($13.46 billion), with the electricity sector expected to absorb between 27 and 30 billion yuan ($5.2-5.8 billion). The remainder was to go to the coal and crude oil industries.

The ministry's initial estimates show that the energy industry turned out 1.09 billion tons of coal, 138 million tons of crude oil, 15 billion cubic metres of natural gas, and 615 billion kilowatt hours of electricity during 1990.

Output fulfilled the State targets for the year and the quotas set for the seventh 5-Year Plan (1986-90).

"China is still a developing country," the vice minister said. "The reason China remains poor is because the countryside is poor. The rural economy is not developed and all the surplus labor is in the countryside."

China has a rural labor force of 400 million, the vice minister said. About 200 million was enough to work on farms, and rural enterprises absorbed a further 93 million. The remaining 107 million laborers could not find work in the countryside, he said.

State Increases Funding for Power Industry

40100029 Beijing CHINA DAILY in English 30 Jan 91 p 2

[Article by staff reporter Huang Xiang]

[Text] The government is to increase investment in the nation's coal and electric power industry by more than 5 billion yuan ($960 million) this year, but analysts fear the increase may not be sufficient to combat the difficulties facing the sector.

Total State appropriations for capital construction of coal mines and electric power works will amount to about 21.5 billion yuan ($4.13 billion) in 1991, according to Yao Zhenyan, president of State Energy Investment Corporation (SEIC).

Of the total, the coal industry would receive around 9 billion yuan ($1.73 billion), including "a small proportion of overseas capital," Yao said, adding that the investment represented a rise of 1.5 billion yuan ($288 million) on the 1990 figure.

In addition, the central government might soon allow the industry to issue bonds or establish special development funds for capital construction, Yao said.

"So the total increase in investment in the coal sector will eventually amount to 2 billion yuan ($384 million), a handsome gain compared with any other period in the decade," he said.

The electricity industry would receive 12.53 billion yuan ($2.41 billion) in 1991, 3.9 billion yuan ($750 million) more than last year.

Yao said the total rise in State investment in the two industries accounted for 50 percent of the nation's increased budget for capital construction in 1991, reflecting the government's preferential treatment of the sector.

However, echoing an opinion held by many in the field, Yao said the infusion was far from enough in view of the slow progress made in building coal shafts and hydropower stations in the last five years.

Newly completed shafts, for instance, would be capable of producing a total of only 112 million tons over the five years, just two-thirds of the State requirement for the industry.

"This will definitely affect coal production in the decade, and additional funding will be necessary if we are to make up the loss. The growth rate of the industry at present is too low," Yao said.

Also disturbing was the lack of funding in hydropower projects, Yao said, explaining that construction of a large-sized hydropower works took several years longer and cost millions of yuan more than a thermal-powered project.

The corporation estimates that it will need at least 13.5 billion yuan ($2.6 billion) a year in funding for hydropower undertakings if it is to fulfill State-set targets up to the year 2000.

"So far local contributions have made up 60 to 70 percent of the annual costs of building hydropower projects," said one expert, urging more government spending in the sector.

In the past few years the corporation has been encouraging more diversified sources of funding.

Some have recommended that the State charge more for electricity, and use the increased earnings to develop the nation's abundant water resources.

Others suggest the projects should have more access to overseas funding which has so far been directed at coal-fired plants, coal-mining and the oil industry.

Growth of Energy in Coastal Region Involves Hard Choices

916B0002A Beijing XIANDAIHUA [MODERNIZATION] in Chinese No 8, Aug 90 pp 18-19

[Article by Li Yingxiang [2621 7751 5046]: "Perplexities and Choices: The Southeast China Coastal Region Takes The First Steps Out of the Energy Trough"]

[Text] China's southeast coastal region, consisting of the city of Shanghai and the provinces of Jiangsu, Zhejiang, Guangdong and Fujian, is an important door and window to the outside world, a strategic forward position in China's blueprint for modernization, and a pacesetter promoting national economic development and scientific and technological progress. Solving this region's energy supply problems and assuring its sustained, stable, coordinated economic development constitute a major task of the energy industry's development and a major topic of research on energy strategy.

1. Serious Perplexities Amid Rapid Development

In the 10 years of reform and opening to the outside world, China's development has proceeded rapidly, and its economy has taken on a new look. Development has been most rapid and the changes have been greatest in the five jurisdictions of the southeastern coastal region. In 1988, their output value was 4.19 times that of 1979 [literally, "was 3.19 times greater"; similarly below], representing an average annual increase of 17.6 percent; their national income increased by a factor of 3.82, or 16.08 percent per year; their total retail sales of social commodities were up by a factor of 4.83, for an annual increase of 19.13 percent; and the value of their exports had increased by a factor of 4.75, an average annual increase of 18.90 percent. These developments and changes not only were unprecedented in the five localities, but also were unmatched by any other region of the country.

But amid this rapid development and immense change, an inadequate supply of energy, especially electrical energy, posed serious problems for this region's further economic development and seriously affected industrial and agricultural production and the livelihood of the masses in the five jurisdictions. Electric power shortages forced many plants to close for 2 or 3 days a week, and one-fourth to one-third of productive capacity was idled. Owing to electric power shortages, a normal supply of electric power could not be assured during the busiest agricultural season, so that some peasants were forced to remain idle, or to sit through the night, wrapped in quilts, at the pumphouses or threshing floors, waiting for the power to be turned on so that they could water the fields or do their threshing and winnowing; owing to electric power shortages, some luxuriously appointed restaurants and markets had no choice but to use kerosene lamps or candles for lighting, and some hospitals even had to temporarily turn off their power and to cease performing operations.

The different aspects of the energy shortage in the southeastern coastal region evoked a variety of responses and widespread concern. As a result, the state allocated large sums for accelerated construction of new electric power plants. The investment in electric power construction for 1988 was 7.77 times that for 1979, representing an annual increase of 25.6 percent. But the growth of power production is still far from keeping pace with industrial development. Total industrial output value in 1988 was 4.68 times as great as that in 1979, representing an annual increase of 18.71 percent, but electric power generation increased by only a factor of 2.12 over the same period, representing an annual increase of 8.72 percent. Not only did electric power development power fail to keep pace with industrial development, but newly constructed power generation capacities generally could not be operated normally because of coal shortages. In December 1988, an average of 2 million kW of electric power generating capacity was idle every day in the East China power grid. In early 1989 in-house electric power plant the Baogang Steel Works actually had to shut down because of coal shortages.

The acute shortages of electric power and coal in the five jurisdictions of the southeastern coastal region have

been greatly alleviated since the second half of 1989 by cooling off of the economy, market weakness, and sub-capacity operation at many plants, but the problems have not been fundamentally resolved. As the policy of rectification and deepening of reform is implemented with increasing thoroughness and as the entire economy recovers, acute energy shortages are likely to recur; and we therefore must seize the favorable moment and consider measures and programs.

2. Optimum Choice Among a Variety of Programs

There are a variety of possible programs for solving the southeastern coastal region's energy problems. China has abundant hydropower and coal resources, and people usually think first of these two conventional energy resources. But 70 percent of the country's hydropower resources are in the southwest, and developing hydropower and transmitting the energy from west to east involves huge distances with excessive grid losses. In addition, because river discharge is highly variable from year to year and from season to season, while we are developing hydropower it will also be necessary to build a set of other electric power plants for load regulation.

When building fossil-fired power plants, coal supply problems must be considered. China has rich coal resources, but geographically they are very unevenly distributed. If we take the Beijing-Guangzhou Railway as the dividing line between east and west, then proven and long-term resources in the east account for only 15 percent of the national total, and the remaining 85 percent is in the west. If we take the Jinling and Dabie mountain ranges as the dividing line between north and south, then 90 percent of coal resources are in the north and only 6 percent in the south. Because the southeast coastal region lacks coal resources, coal for industrial and agricultural production and the people's livelihood is largely shipped from other provinces. In the last decade, as industrial and agricultural production has expanded and the people's standard of living has risen, increasing amounts of coal have been brought in from outside: the increase from 1979 to 1988 was 70.55 percent, an average of 6.11 percent per year. Coal from northern Shanxi must be transported more than 2000 km to reach Shanghai, more than 2800 km to Xiamen, and more than 3300 km to Guangzhou. This haulage of heavy loads over long distances puts a great deal of pressure on all railroads and water transport.

Coal-fired power generation not only puts a great deal of pressure on the transport system, but also is a heavy burden in regard to environmental pollution. Each year, a million-kW fossil-fired power plant discharges several tens of thousands of tons of sulfur dioxide, nitrogen oxides and similar harmful gases into the environment, more than 100 kilograms of mercury and cadmium, and also such carcinogens as 3,4-benzpyrene, which can do great harm to the environment and to people. Of the ten greatest pollution incidents worldwide, eight were caused by gaseous pollutants in smoke. The London smog incident of December 1952 resulted in the tragic deaths of more than 4000 persons in a city of 3.3 million in the course of several days as a result of car accidents and the like. At the same time, prolonged air pollution increased the incidence of respiratory disease, pneumonia and cancer severalfold and seriously harmed people's health. A historical lesson should be learned from this event. In addition, investigations by environmental scientists throughout the world indicate that the large-scale use of such fossil fuels as coal is causing a steady increase in the concentration of carbon dioxide in the atmosphere, thus producing a greenhouse effect that will cause a degradation of global climate and environmental conditions, a rise in sea level and an expansion of desert areas, and might bring disaster to mankind.

As a result of the above limitations and undesirable aspects of the development of conventional energy sources in the southeastern coastal region, some believe that in the next 30 years, the world, and particularly the industrially developed countries, will vigorously develop a new energy source, nuclear power. This type of power has many advantages. First, its cost is low. Foreign experience indicates at although the construction costs for nuclear power plants are higher than those for fossil-fired power plants, the fuel costs are only a fraction as great; the cost of a kilowatt-hour of power is only 20 to 40 percent with nuclear power as for fossil-fired plants. Second, the transport requirements for nuclear fuel are small. A million-kW nuclear power plant with a pressurized water reactor requires only 30 tons of fuel per year, while a coal-fired power plant of the same capacity requires 3 million tons of coal per year. Thus, the transport requirements for nuclear power are minuscule. Third, it does not pollute the environment. Nuclear power plants do not produce the billows of thick smoke that are constantly seen issuing from fossil-fired power plants, and they produce no environmental effects. In normal operation, the rare gases and microscopic amounts of radioactive substances that are discharged by a million-kilowatt nuclear power plant expose nearby residents to a radiation dose equivalent to watching 4 hours of television. Fourth, the risk is low. World nuclear power plants now have an aggregate total of more than 5,000 reactor-years of operation, and there have been only two serious accidents. One was the accident at Three Mile Island in the United States, which caused no harm to the environment or the public and produced no injuries or deaths among plant personnel. The other was the accident at Chernobyl in the Soviet Union, in which more than 30 persons died and the escape of a large amount of radioactive gases and fission products caused a panic in neighboring countries. But this radioactive dust had entirely broken down in 1 to 2 weeks, leaving no aftereffects. The Chernobyl accident was entirely the result of human error and was essentially preventable. Nuclear power is safe and reliable. Although nuclear power plants do involve a risk, probability analysis indicates that it is much less than other industrial and social risks. An easily grasped illustration is the fact that every year more than 10,000 persons die worldwide as a

result of coal-mine gas explosions and plane and automobile crashes, but until the time of the Chernobyl accident there had been no deaths in nuclear power.

3. The Key to Developing Nuclear Power Is Strong Strategic Resolve

More and more people are coming to the realization that China must develop nuclear power; in particular, the southeast coastal region, which is short of energy resources, has no recourse but to develop nuclear power. China has many conditions that are favorable for the development of nuclear power. First, it has relatively abundant uranium resources, sufficient for the development of nuclear power. Second, in the process of developing nuclear weapons, China has created a complete nuclear science and technology system ranging from uranium mining, isotope separation, and nuclear fuel element production to nuclear reactors and spent fuel postprocessing. Third, and most important, China has already developed a contingent of nuclear specialists with high political qualifications and strong technical abilities that can face up to difficulties and handle arduous work. This contingent posted an outstanding achievement in developing China's nuclear weapons program, and in the future it certainly will make an even greater contribution in developing the nuclear power industry.

But even if it is universally recognized that China must develop nuclear power and that it has several conditions favorable to the development of nuclear power, the circumstances under which CHina must develop nuclear power are far from ideal. Not only did we get a rather late start and waste valuable time, but our investments in the field have been small, and it is difficult to provide the necessary support for the startup of nuclear power construction. Bricks cannot be made without straw. There are many reasons, some objective and some subjective. The objective factors are that China is still a developing nation, with a vast population and limited national wealth, so that it is short of funds for the many industries that are necessarily involved in modernization; the subjective factors are that there is an inadequate awareness of nuclear power's strategic position and role in China's long-term energy development, that we lack a sense of urgency regarding the development of nuclear power, the gradual betterment of China, and the improvement of China's energy structure, in particular that of the southeast coastal region, and about alleviating the pressure on the transport industry and protecting the environment, and that we lack a resolute, correct leadership policy, strategic resolution, and an effective, comprehensive, scientific plan and support policy for the development of nuclear power. As a result, progress in the development of nuclear power has long been slow and painful.

Faced with energy shortages, transportation shortages, and degradation of the environment, people are crying out for the accelerated development of nuclear power; and in particular, as we face the economic and social development of the 21st Century, people are even more eager for us to quickly produce practicable answers and workable arrangements for the development of nuclear power.

First, we need strong strategic resolve. In this respect, certain foreign experience is well worth our learning from. In 1973, during the world oil o73 crisis, the French government decided that no more oil-fired power plants would be built and that it would do everything possible to accelerate the development of nuclear power. Nuclear power then grew so rapidly that after only 17 years it accounted for 80 percent of all electric power generated in the country, converting France from an energy-strapped industrial country to an exporter of electric power. At about the same time, at its 24th, 25th and 26th party congresses, the Soviet Union passed nuclear power construction programs and made the decision to vigorously develop the manufacture of nuclear power machinery and to engage in priority construction of nuclear power plants in the European USSR, with the result that Soviet nuclear power plant construction sustained a rapid pace. After the earth-shaking Chernobyl accident in April 1986, it did not slacken in its resolve to develop nuclear power.

Second, we must have a scientific, steady, effective long-term development program. Nuclear power construction is a huge and complex systems undertaking that involves many departments, so that without a unified program and long-term, planning, the inevitable result will be chaos and an adverse effect on the sustained, stable, coordinated development of nuclear power. At the same time, the nuclear power development program must be scientific and realistic, and it must strike an overall balance in which each item is conscientiously documented and realistically evaluated: otherwise it will fail to have the proper organizing and guiding effect on nuclear power development.

Third, we must have a stable, reliable source of funding. Nuclear power is a promising new arrival in the field of energy development, and the country's energy construction funding currently does not include it as a separate item. Piecemeal funding is hard to sustain, and in the future, during readjustment of the energy structure, it will be necessary to incorporate nuclear power construction into the central and local energy construction funding channels so that it obtains its proper share. In the long term, the economic performance of nuclear power will certainly be good, and there is every likelihood that it will be self-supporting, thus initiating a beneficial cycle of self-development that will make a continuous contribution to nuclear power. But during the initial stage, nuclear power must receive continuous state support if it is to develop.

Fourth, we must have a highly centralized and unified management system. Nuclear technology is complex and involves a wide variety of departments. Safety requirements are extremely stringent and in addition are politically sensitive: any problem may become a major one. If, instead of highly centralized and unified leadership,

with decisive policy making and highly effective management, we have many sources of authority and divergent views, leading to discussion without decision making or decision making without implementation, the undertaking will be a failure and will produce losses or even major undesirable economic or political consequences.

The Qinshan and Dayawan nuclear power plants that are currently under construction in China's southeastern coastal region are major milestones in China's newly begun nuclear power development effort, but are also represent major beginning in altering the region's energy structure. At present the projects are advancing smoothly and with high quality, producing encouraging results and engendering a confidence that we are fully capable of mastering and developing nuclear technology and further developing China's nuclear power industry, so that the flowering of nuclear power across the broad land of China will bear ample economic fruit and create wealth for the people.

Excessive Importation of Power Units Questioned

916B0014 Shanghai DONGLI GONGCHENG [POWER ENGINEERING] in Chinese Vol 10, No 5, 15 Oct 90 pp 33-35, 13

[Article by Song Jiliang [1345 4949 5328]: "Objections To Importing Large Amounts of Power Generation Equipment"]

[Text] Abstract

Based on the fact that China is self-sufficient in and has surpluses of power generation equipment, that imported generators are not necessarily of the highest quality, that prices of imported generators are somewhat high, and other reasons, this article objects to the importation of large amounts of power generation equipment. It also offers some suggestions concerning invigoration of our national economy, transforming power plants, and developing new and incisive large-scale Chinese-made power generation equipment.

Main terms: power generation equipment, imports

Officials in the State Planning Commission recently pointed out that "we certainly must restrict imports of foreign generators and should support and protect the state's power generation equipment manufacturing industry".

Given the surge in power generation equipment imports over the past several years and motions for importing large amounts of power generation equipment, there is a need for discussion.

According to reports, we had already signed import contracts for 12,000MW in power generation equipment up to the end of February 1988 and we are now involved in discussions for 37,270MW in goods exchange trade contracts.

The total installed generating capacity of power generation equipment in China in the 40 years since our nation was founded is 120,000MW, so the above imports account for one-third. During the entire Sixth 5-Year Plan (1981-1985), the total capacity of power generation equipment produced in China was 16,040MW, so these imports are more than double to output during the Sixth 5-Year Plan and they exceeded the total amount of imports in Chinese history. Thus, the amount of these imports cannot but alarm people.

Importing power generation equipment during the early period after the nation was founded was necessary. Since the 1970's, China has been able to design and manufacture new and incisive power generation equipment and our manufacturing plants and professional personnel are world leaders. Moreover, some of our large-scale power generation equipment has entered international markets. In this sort of situation, continued importing of large amounts is hard to understand.

I. China Is Self-Sufficient and Has a Surplus in Power Generation Equipment Output

China's electric power shortage has continued to sharpen over the past decade. Our shortage of power generation equipment installed generating capacity was 10,000MW in 1978, 12,000MW in 1984, and 15,000MW in 1987. It has risen even further to 17,000 to 19,000MW in the past few years. It is easy for people to misunderstand this growing electric power shortage. It would appear that output of Chinese-made power generation equipment cannot satisfy the electric power requirements for development of the entire national economy, so we must import large amounts. The actual situation, however, is just the opposite. The objective fact is that our power generation equipment manufacturing capacity is capable of ensuring self-sufficiency and even has a surplus. The real reason for the electric power shortage over the past several years is our failure to take full advantage of the production capacity in our power generation equipment manufacturing industry. There were already indications of an electric power shortage during the Sixth 5-Year Plan, but arrangements for output of power generation equipment during the Sixth 5-Year Plan did not call for a substantial increase in output over the Fifth 5-Year Plan. Instead, output was reduced and the extent of the reduction in output was extremely large. Output dropped from 22,420MW during the Fifth 5-Year Plan to 16,040MW in the Sixth 5-Year Plan. One can see that if there had not been a decrease in output from the Fifth 5-Year Plan to the Sixth 5-Year Plan and instead there had been a slow rate of growth or even a zero rate of growth, this would not have created the severe electric power shortage we have experienced over the past several years.

We may have absorbed the lesson from the Sixth 5-Year Plan that we should not reduce output of power generation equipment. During the first 4 years of the Seventh 5-Year Plan, output grew each year. The figure in 1986 was over 20 percent higher than in 1985, reaching

7,120MW, and it grew to 9,600MW in 1987, 10,970MW in 1988, and 11,560MW in 1989.

It should be explained that although output during 1989 reached its highest historical level, we did not take peak advantage of production capacity. For example, our production capacity for hydropower equipment was 3,000MW but we only produced 1,000MW-plus.

Since China is self-sufficient and has a surplus in power generation equipment output, the inevitable outcome from continuing to import large amounts of power generation equipment would be to restrict our national industry. I have learned that there will be a reduction in output of power generation equipment in China in 1990 and further reductions in output over the next 3 years until average yearly output drops to 5,700MW. If this is the case, the negative effects on the personal economic interests of the hundreds of thousands of employees in the power generation equipment manufacturing industry and on progress in the four modernizations drive and our national feelings are self-evident. Comments in this area go beyond the scope of this discussion and will be dropped.

II. Imported Generators Are Not Necessarily Better Than Chinese-Made Generators

During the first "5,000MW battle", imported generators accounted for 1,300MW. Statistics for 1 year after they were placed into operation show that the maximum power generation time for these imported generators was only 4,302 hours and the lowest was just 2,162 hours. Czech generators, for example, have both design problems and manufacturing quality problems. After large amounts of renovation, the utilization rate of the equipment was only 50 percent. Moreover, generators imported from Belgium and France suffered over seven accidents which forced shutdowns due to manufacturing quality and design problems. On the other hand, the average power generation hours for Chinese-made generators that went into operation over the same time period was 5,688 hours and was as high as 7,777 hours for the best cases. Although comprehensive testing has not been done for coal consumption in the imported generators, we have learned from measurement data for one unit that coal consumption for power supply was as high as 471 g/kWh, much poorer than Chinese-made generators.

In another example, design problems on the Japanese side for the generators at Huaneng Dalian Power Plant led to the discovery of serious deformation in the steel structural supports in part of the plant building prior to startup of the first generator at the power plant and it again was eventually remedied by Chinese workers and technical personnel.

China's national industry is in no way inferior in product quality, construction schedules, and invest per unit capacity. Some foreign-made generators do have certain technical advantages and we can import one or two units to use as references, but we should not import them in large numbers. This would make it hard to avoid importing several high-priced poor quality generators like the 800MW generators imported from the Soviet Union, for example. When supercritical parameters are adopted, in principle coal consumption should be lower, but actually it was 1.2 percent higher than Chinese-made subcritical parameter 600MW generators.

III. Imported Generators Have Higher Prices and Power Generation Costs

If Chinese loses this 37,270MW order, we would also lose several 100 million yuan in value of output, which would also result in a loss of many 100 million of yuan in profits for enterprises and the state would lose several 100 million yuan in income from taxes and profits (for example, the Shanghai Gas Turbine Plant had a value of output of 166 million yuan in 1989 with profits of 30.07 million yuan and turned over 48.29 million yuan in profits and taxes to higher authorities).

According to statistics for 40 electric power projects completed from 1984 to 1986, the unit investment for power plants using imported equipment was 1,520 yuan/kW but this figure was just 771 yuan in power plants with Chinese-made generators. Because of the especially high price of imported power generation equipment, the inevitable outcome is that the investment per unit capacity for power plants will be expensive.

The cost of nuclear power in foreign countries is usually cheaper than thermal power but the unit investment for capacity is especially high for the Guangdong Nuclear Power Plant because the equipment is imported, so the cost of the power it generates will also be especially high.

Because the power generation costs of imported equipment are higher than for Chinese-made equipment, the inevitable result is increased costs for industrial products which eventually must be borne by vast numbers of consumers for long periods.

IV. Proposals

A. We should immediately suspend power generation equipment import contracts that have not been signed

To import power generation equipment, it would seem that exchanging goods for goods would not consume foreign exchange but actually there is no difference from using foreign exchange for the imports. To protect normal development of China's national industry and safeguard the interests of the large number of employees in manufacturing industries, we should immediately suspend power generation equipment import projects that have not been signed, even if they involve exchanging goods for goods and we should make active arrangements for those that have already been signed such as transferring them to third countries.

B. Power plants should have the right to decide which generators to purchase

Normally, the choice of generators (imported or Chinese-made) should be made by administrators who have a direct economic relationship to the project because the managers would certainly select the generators with the best economic benefits (low equipment price, low power generation cost, high profit). In the past, however, several electric power projects in China were not handled this way. Some companies had the authority to import large capacity power generation equipment but bore no responsibility for their economic benefits, whereas power plants had no authority to decide on the generators to purchase. The defects in this sort of method are obvious.

C. If imports are necessary, decision makers also should consider:

1. They should not render domestic manufacturing capabilities useless, but they can instead be used to produce several large power generators to replace the large number of medium-sized and small generators that have already exceeded their service life, have high energy consumption, and poor economic results.

2. We should not import from several countries. Countries from which we are importing include England, the United States, the Soviet Union, Japan, Italy, France, West Germany, Switzerland, Austria, Czechoslovakia, Canada, and others and there are great price differentials among them. If we import from many countries, this would make future repairs, component systemization, a shift to batch production, and many other things quite inconvenient.

D. We must comprehensively assess the economic benefits from electric power projects

The propaganda in some articles or reports concerning imported electric power projects is often trivial. For example, they may advocate prominently a single type of index but fail to discuss investment per unit capacity, power generation costs, profits and taxes per 100 yuan in capital, and other things that are most capable of embodying economic benefits. I can provide some examples:

1. An article described the imported Guangdong Nuclear Power Plant by saying that since it will use nuclear fuel, it can conserve 5 million tons of raw coal annually. It fails to mention, however, that to conserve this 5 million tons we will have to export 10 million tons of coal each year to repay the interest we must pay to foreign countries each year on the loan.

2. While recommending a certain type of imported generator, some companies asserted that it will conserve $2.5 million annually in coal expenditures but they fail to mention that it will consume an additional several 100 million yuan in investments as the cost of this.

3. A certain newspaper stated in a report on a certain imported power plant that it will "have a high degree of automatic control" and thus "the entire plant will have just 700 employees", but it does not mention the additional investment that will have to be paid.

E. Feasibility research for electric power projects must be established on a foundation of a respect for science

If feasibility research and debate for electric power projects (and this can include all construction projects) are not based on a foundation of science and respect for facts, the conclusions drawn will inevitably "involve even greater deception and risk and will be worse than no debate at all". There is no lack of examples of lessons in this area. For example: 1) The original feasibility report and debate for a certain enormous hydropower project stated that the total investment would be 15.95 billion yuan but the results of survey research by experts in all areas in the National Chinese People's Political Consultative Conference showed that it would exceed 60 billion yuan. Moreover, calculations by the Construction Bank's Investment Survey Department showed that it would be 107.8 billion yuan, so there were huge discrepancies. It will not be built in the future, but the several 100 million yuan in capital construction investments that we have already spent were just thrown away. 2) The feasibility research report for a certain nuclear power plant stated that the annual interest rate would be 3.83 percent to manufacture this imported nuclear power plant (it acknowledged that this 3.83 percent interest rate was correct as well as the fact that it was much lower than regular power plants in China). The report used these measures:

a. The report did not mention the cost of treating the abandoned reactor and radioactive material after it had reached the end of its useful life. This expense cannot be ignored, however, and would involve several 100 million yuan.

b. The annual depreciation rate for this nuclear power plant was assumed to be 3.3 percent but previous examples were 5 percent. This item alone artificially lowered the cost by several 100 million yuan.

c. To show that the economic benefits were superior for this imported nuclear power plant, they did not use national electric power average indices for comparison but instead used the imported K Power Plant with its high construction costs and poor economic benefits for comparison.

d. When calculating the cost of nuclear power, this report only calculated expenses in the four areas of fuel, depreciation, major repairs, and operation, but when they compared it with thermal power, they added "additional costs" beyond these four items.

e. This report calculated the price of coal burned for thermal power at $50 per ton, but the actual price of coal burned in China's thermal power plants is far lower than this. Even the price of the coal China exports is less than $50 (just slightly over $40). The report used this to "prove" that the power generation costs of imported nuclear power are low.

The goal of listing these examples in this article is to make an appeal: in dealing with debate, reports, and propaganda concerning imported power plants, we should take an scientific attitude of seeking truth from facts. Only in this way will it be possible to ensure that the decisions by leaders have a scientific foundation. In concluding this article, I would like to quote a paragraph of encouragement: "Soft science research must be relatively independent of the effects of the will of decision makers. It can only be examined by practice and be responsible to the people and history. Matters cannot be handled by looking at the meaningful glances of leaders". In future decisions concerning any type of major question, we cannot stop at traditional methods and levels of handling matters by relying on the individual experience and will of leaders. We must adopt scientific methods and carry out scientific debate according to scientific procedures.

China Imports Big Soviet Generators

40200027b Beijing CHINA DAILY in English 29 Dec 90 p 2

[Article by staff reporter Huang Xiang]

[Text] China's power industry this week made two landmark purchases from the Soviet Union.

The imports, four sets of Soviet-made high-capacity generating units, will include two of the most powerful generators ever installed in China.

The contracts were signed in Beijing between Chinese buyers and the Soviet Tech-Industry Export Corporation, the supplier of the equipment.

All of the four generators, two of 800,000 and two of 300,000-kilowatts in capacity, will be installed in Northeast China's Liaoning, a heavily-industrialized province which has long suffered from a power shortage.

The two bigger units will be installed in the Province's Suizhong Power Plant, a key State power project included in the forthcoming Eighth 5-Year Plan (1991-1995).

With a contract value of $669 million, it will be carried out in the traditional form of barter trade. But both sides declined to give further details.

The two smaller units, each with a capacity of 300,000 kilowatts, have been purchased for Huaneng Yingkou Power Plant in the province's coastal city of Yingkou.

The Chinese refused to give details of the contract value except to say that the deal involves long-term loans from the Soviet side as well as barter trade.

According to a Chinese businessman attending the contract-signing ceremony, the Chinese will in return repair Soviet shipping and supply light industrial products. And the long-term loans will be paid back in the form of electricity sales upon the completion of the power plant, scheduled to start operation in February, 1994.

Tianjin Institute of Power Sources Focuses on Photovoltaics Research

916B0013 Chongqing XINNENGYUAN [NEW ENERGY SOURCES], in Chinese Vol 12, No 11, Nov 90 pp 1-4

[Article by Song Libin [1345 4409 1755] of the Tianjin Institute of Power Sources: "Photovoltaics Technology at China's Tianjin Institute of Power Sources"]

[Text] Abstract

Tianjin Institute of Power Sources (TIPS) monocrystalline silicon solar cells were used on spacecraft as early as 1970. They began shifting from space to ground applications in the mid-1970's. Over the past 20 years, they have developed new solar cell materials, cell preparation techniques, system design, testing methods, and so on. The maximum efficiency of their new high-efficiency solar cells now exceeds 20 percent (2 X 2 cm^2, 25° C, AM1.5). The maximum efficiency in the laboratory of the solar cells for use in space has reached 10.2 percent (area 25 mm^2, AM1.5). In addition, they have also developed light-gathering cells and square matrices, GaAs, Cu_2S/CdS, and MiS solar cells, and so on.

Introduction

China is a vast country with a huge population, and it has abundant solar energy resources. There is a very large latent market for the utilization of solar energy in China. Solar cells are an important branch of solar energy utilization. The Tianjin Institute of Power Sources (TIPS) began studying and developing monocrystalline silicon solar cells back in 1958 and provided them for use on a spacecraft in 1970. To date, the solar cell matrices used in the energy systems of the LEO and GEO satellites were provided by TIPS. Beginning in the mid-1970's, solar cell applications shifted from space to the ground. The primary direction of research was to reduce the cost of solar cells (including materials and manufacturing techniques). The earliest ground application of solar cells was in a searchlight at Tianjin harbor. Subsequently, there were also utilized in railroad signal lights, microwave relay stations, electric fence power sources, and other realms.

For the past 10-plus years, TIPS has developed solar cell materials, different types of cell preparation techniques, system design and solar cell testing technologies, and so on. They have accumulated rich experience in these areas and trained several new photovoltaic technology personnel who frequently engage in international photovoltaic technology exchanges. The International PVSEC-2 Conference held in Beijing in 1980 was also organized by TIPS.

I. New MGPESC High-Efficiency Silicon Solar Cells

For ideal materials and structures, the efficiency of monocrystalline silicon solar cells is limited to 25 percent (AM1.5, 25°C). To attain this goal, the effects of dark current on the cells must be reduced to a minimum. For this reason, appropriate control of the reflection region doping concentration and purification of the reflection region surface can obviously reduce dark current in solar cells and thereby increase the open-circuit voltage of solar cells. Using 0.1 to 0.3 Ω p-type zone melt silicon as a substrate, the dimensions of the cells are 2 cm X 2 cm X 0.35 mm. Gas portable $PoCl_3$ diffusion was used to prepare the p-n junction, and a purified SiO_2 layer was grown thermally. The p^+ layer was composed of aluminum alloy to facilitate the formation of an excellent ohmic contact. A dual-layer reflection-reducing film was used and the grid lines account for 2 to 3 percent of the area of the solar cell. The photoelectric conversion efficiency of this type of cell can reach 19.32 percent (AM1.5, 25° C). To further increase the efficiency of this cell, we solved the problem of orthogonal photoetching of the surface of the V-shaped grooves and achieved an MGPESC (Micro-Grooved Passivated Emitter Solar Cell) structure. The light reflection losses of the cell surface was reduced from 2 to 3 percent for the original illuminated surface PESC to less than 1 percent. Moreover, the refraction effects of V-shaped grooves on the incident light placed the light absorption closer to the p-n junction region, which was even more favorable for photoelectric conversion and increased the short-circuit current density of the cells by about 5 percent. There was an increase of about 1 percent in the absolute efficiency of the cells, so the photoelectric conversion efficiency of the MGPESC high-efficiency silicon solar cells exceed 20 percent. Moreover, we did space environment simulation experiments with this type of cell and completed illumination experiments after 600 hours of PESC high-efficiency cell 1 MeV electron irradiation which proved that there was no apparent degradation of the performance of this cell and showed that there was potential for using the cells in low-orbit satellites.

II. Space Large-Area Silicon Solar Cells

The early satellites that China launched used 10 X 20 mm^2 solar cells. TIPS has been producing these cells for more than a decade. There were continual improvements in cell technology and continual improvements in production levels during this period but cell performance still fell far below meeting the high power, long lifespan, and high reliability technical requirements of new satellites, so we had to adopt the corresponding technical measures such as shallow junctions, dense grids, back fields, back reflectors, dual-layer reflection-reducing film, improving electrode contact, and so on. Shallow junctions can eliminate heavy doping layers, reduce dislocation density, and further improve the short-wave response of the solar cells, which increased the short-circuit current of the solar cells. Because the cells employed shallow junctions, the resistance of the diffusion layer could increase. Using conventional cell grid-line electrodes would increase the series resistance of the cells and thereby reduce the filling factors of the cells, so the goal of increasing cell efficiency could not be reached. To eliminate these negative factors, the number

of grid lines in the cells had to be increased, but this would reduce the effective illumination area of the cells, so we had to prepare thin upper surface grid line electrodes. When preparing the lower electrodes, an aluminum layer was placed in direct contact with the silicon to create mirror-surface reflections in order to increase the long-wave response of the cells. Moreover, an ohmic contact was formed between the aluminum and the p-region silicon, which also played a role in reducing the working temperature of the solar cells. The reflection coefficient of the monocrystalline silicon varies with the wavelength of the incident light, so for the silicon the reflection coefficient of the shortwave portion and the maximum reflection coefficient of the long-wave portion could be 60 and 30 percent, respectively. As a result, we had to use a dual-layer reflection-reducing film to achieve a significant reduction in reflection effects.

The electrodes used in the space solar cells were aluminum-silver impregnated with tin, titanium-silver impregnated with tin, titanium-palladium-silver electrodes, and so on. Impregnation with tin increased the weight, so we usually adopted titanium-palladium-silver electrodes and carried out tin-less soldering. The 4 X 6 cm^2 cells prepared for use in space and the 2 X 2 cm^2 and 2 X 4 cm^2 cells are now being produced in batch quantities. The maximum efficiency in the laboratory is 15.8 percent (AM0) and their production efficiency is 11 to 12 percent.

III. Research on Cell Materials and Other Solar Cell Components

To reduce the cost of silicon solar cells, we used metallurgical silicon as a raw material. After crushing, it was sifted with a 60 to 180 mu screen and chemical processes were used to dissolve out the impurities in the metallurgical silicon, after which we carried out physical purification and finally a direct drawing method to draw polycrystalline silicon rods. Conventional cell preparation techniques were used to manufacture the polycrystalline solar cells whose photoelectric conversion efficiency was 10 to 11 percent (AM1.5, 25° C).

To further reduce the manufacturing costs of the solar cells, we also developed silk screen leak printed electrodes. The photoelectric conversion efficiency of the cells prepared in this manner was basically near that of cells prepared using vacuum evaporation plating electrodes.

Research was conducted on Cu_2S/CdS thin film solar cells. We used metallic polyimide film as a substrate and vacuum evaporation plating of a CdS thin film (thickness of a few 10 µm). The hot dip method (wet method) was used for form the p-n junctions, and finally we used previously photoetched metallic grids for thermocompression to contact the Cu_2 in the p-layer. The area of these cells was about 10 cm^2 and their photoelectric conversion efficiency was 7 to 8 percent (AM1.5, 25° C). On this foundation, we also developed $Cu_2S/CdZnS$ thin film solar cells. The manufacturing technique used for these cells was to mix in an appropriate amount of Zn during evaporation plating with CdS. The other preparation techniques were identical to those used for the Cu_2S/CdS cells. The open-circuit voltage of these cells was several 10 mV higher than the Cu_2S/CdS cells but their short-circuit current density was lower. Because they were in a sub-stable state, the Cu_2S/CdS solar cells and the $Cu_2S/CdZnS$ cells had poorer stability.

The liquid phase extension method was used to manufacture heterogeneous surface p-GaAlAs/p-GaAs/n-GaAs solar cells. We studied the effects of different metals on MIS silicon solar cells. We also explored manufacturing techniques for vertical junction silicon solar cells. We etched several vertical grooves on the surface of the cells. The grooves were 100 µm wide, 70 µm deep, and had walls 90 µm thick. This unusual structure caused photovoltaic effects to occur in locations extremely close to the collector. As a result, the irradiation caused a significant reduction in the effects of degradation in the length of charge current on collector efficiency. The electron irradiation resistance performance of this cells was somewhat stronger than conventional flat silicon solar cells.

Research on light-gathering solar cells showed that for cells which operated under high light intensities, the main question was the need to reduce the series resistance as much as possible. Otherwise, their power output would be severely restricted. The main parameters related to this question were: the various parameters of the substrate material, the n^+-p junction and n^+-p-p^+ junction, the graphic design of the electrodes, the diffusion layer on the surface of the cells, the characteristics of the p-n junction, the reflection-reducing film, and so on. The cell efficiency of the φ 40 mm light-gathering cells under conditions of 40 to 50 suns and AM1.5, 25° C exceeded 19 percent.

Non-crystalline silicon solar cells have advantages like being inexpensive, being adapted to industrialized production in large amounts, and so on. The structure of the experimental cells at TIPS was: ITO/SiO_2n-αSiC:H/i-αSI:H/p-McSI:H/Mo. Because a purified film layer was prepared for the surface of the cells, this reduced the speed of carrier recombination. This optimized the amount of boron mixed in this layer. This caused the non-crystalline silicon solar cells with an area of 0.25 cm^2 to have a photoelectric conversion efficiency of 10.42 percent under conditions of AM1.5, 100 W/cm^2, and 29° C. The efficiency of the cells 1 cm^2 in area was 8.02 percent. Irradiation experiments lasting 1,000 hours were conducted for the cells with glass substrates and the theory and practice confirmed attenuation in the non-crystalline silicon solar cells. Because of the rather strong light irradiation, we discovered that not only was there an obvious increase in the spatial load region concentration, but also that there was an obvious decrease in the effective doping concentration in the n region and p region. The indium atoms diffused toward the p layer and the boron atoms diffused toward the i layer, causing reduced conductance. Under sustained

illumination, the Si:H bonds were broken. This was the main cause for the attenuation in the non-crystalline silicon solar cells. We used the techniques used to manufacture the non-crystalline silicon solar cells to manufacture non-crystalline silicon cell assemblies for use in computers and non-crystalline silicon drums. The computer could operate normally at 100 1x and the non-crystalline silicon drums were a type of large-area graphic transducer that could be used in laser copiers, laser lamp printers, laser typewriters, and so on.

In addition, TIPS used the technology for manufacturing monocrystalline silicon solar cells to manufacture solar cell sensors for different purposes and silicon solar sensor cells of different dimensions for use on satellites. The solar sensor cells were also a type of photoelectric conversion component. Because of their small volume, light weight, long lifespan, stable performance, small time constant, low noise, good temperature characteristics, good light spectrum properties, strong resistance to interference, good matching characteristics with solar light and artificial solar simulator light spectra, they were quite capable of satisfying space applications. They could measure the attitude angle of a satellite relative to the sun and could measure the attitude angle velocity of a satellite. As a result, solar sensor cells are being widely applied in all types of satellites. We also did some exploratory research on photoelectric chemical solar cells and other things.

IV. Research on Photovoltaic Testing Technology and Solar Cell Systems

To correctly reflect the properties of solar cells, measurement of solar cells is obviously very important.

The properties of solar cells are determined mainly by materials. The materials parameters with the greatest effects on solar cell performance include small carrier lifespan, diffusion length, surface recombination speed, and so on, and manufacturing techniques can directly affect the performance of cells.

The illumination volt-ampere properties curve of cells can provide the solar cell open circuit voltage, short-circuit current and filling factors, and cell efficiency. In addition, dark volt-ampere characteristics curves, especially dark volt-ampere characteristics curves with temperatures as a parameter are very useful in evaluating the maximum recombination mechanisms of solar cells and assessing the internal parameters of solar cells (such as series resistance R_S, shunt resistance R_{Sh}, diode ideal factor A, dark current or reverse saturation current, and so on).

Obtaining an illumination volt-ampere characteristics curve of a solar cell is done by using solar simulators and electron loads. A calibrated solar cell is used as a standard and this is used to make two more standards. On the ground, the light spectrum usually employed is AM1.5. The light spectrum employed for space applications is AM0. As everyone knows, if the light spectrum of the solar simulator conforms entirely to the AM1.5 or AM0 spectrum, there are no further special requirements on the standard solar cell when measuring the cell being tested. This means that the solar cell being measured conforms completely to the spectrum of the standard solar cell, so there are no further special requirements on the spectrum of the solar simulator. Actually, all of this cannot be achieved, so volt-ampere testing technology has become an important link in photovoltaic activities.

Research on solar cell systems for space applications done at TIPS is mainly focused on low-orbit, medium-orbit, and high-orbit satellites, which requires long lifespans and high stability. The solar cell matrix indices for the No XX satellite to be launched have already been obtained: surface specific power 116.0 W/m^2 and weight specific power 85.04 W/kg.

Solar cell systems used on the ground are mainly used for railroad signals, light towers, communications, and other areas. The solar cell systems used on the ground are composed of glass and PVB seals. The matrix efficiency is less than 10 percent, and the exterior dimensions come in two types: 252 X 162 mm^2 and 482 X 330 mm^2 The weight, working voltage, and maximum power are 0.9 kg, 9 V, 2 W and 3 kg, 4 V, 8 W, respectively (measurement conditions are 25° C, 100 mw/cm^2, and AM1.5).

V. The Future of Photovoltaics at TIPS

To meet the needs of China's space energy systems and future technical development, the high-efficiency silicon solar cells at TIPS must strive in the direction of a photoelectric conversion efficiency greater than 17 percent. The production efficiency of solar cells for use in space must be greater than 12 percent (AM0). The main goals are high power density, large area, high resistance to irradiation, and so on.

We will strengthen development of GaAs solar cells, InP solar cells, and multi-junction high-efficiency solar cells and exploratory research on other new types of solar cells.

The main focus for solar cells for use on the ground is on monocrystalline silicon solar cells and we will strive in the direction of surpassing a matrix efficiency of 10 percent. We will do research on large area and stability problems for non-crystalline silicon solar cells. We will utilize non-crystalline thin film techniques and reinforce development of other non-crystalline silicon components on the basis of non-crystalline thin film.

TIPS has over 30 years of experience in research, development, production, and application of solar cells. We have a rather strong specialized technical staff and widespread channels for international exchanges. We will make greater contributions to photovoltaic activities in China.

Comrades Dai Banghong [2071 6721 1347] and Li Guanghui [2621 0342 6540] participated in this research work.

East China Grid Construction Achieves Breakthrough

916B0024A Shanghai JIEFANG RIBAO in Chinese 25 Nov 90 p 3

[Text] The Seventh 5-Year Plan period has seen rapid strides in the development of the East China grid. Power generation capacity has increased at an average annual rate of 10.2 percent. Important breakthroughs have been achieved in the scale, speed, and technical level in the construction of power stations. The new increase in the generating capacity in the grid accounts for 16.8 percent of the national total and also the total generating capacity accounts for 16.4 percent of the national total. It has become the nation's largest inter-province power grid system among the nation's 500-kilovolt transmission grids centered around medium-to-large power stations.

The power shortage problem was very severe in the city of Shanghai and the provinces of Jiangsu, Zhejiang, and Anhui—all areas under the distribution of the East China grid—in the three years prior to the Seventh 5-Year Plan period. The discrepancy between the supply and demand for power is acute. The East China grid was built based on the economic development needs of the region and relying on the national policy of inclination toward energy and therefore the chances of power grid construction was tightly grasped. By the end of October this year, 97.3 percent of the power grid plan under the national plan had been completed. By the end of the year, three more power-generating plants will be put into operation to generate electricity, thus completing 102.4 percent of the national plan. Total generation capacity within the grid will reach 22 million kilowatts, which represents a 1.2 times increase compared to 1980, and thus fulfilling the goal of doubling capacity within 10 years. In the Seventh Five-Year Plan period, two 1,500-km-long 500-kilovolt power transmission main arteries were constructed spanning between Xuzhou, Jiangsu in the east, and Huainan, Anhui in the west and converging on Nanchao, Shanghai City. Also constructed were six 500-kilovolt power transformer stations with a capacity of 4.25 million kilovolt-amperes, thus forming a 500-kilovolt power transmission grid framework. To integrate the East China and the Central China inter-province grids, a 500-kilovolt positive and negative d.c. power transmission line was constructed with a total length of 1,046 kilometers, linking Gezhouba to Shanghai City, and with a transmission capacity of 1.2 million kilowatts. Since it was put into operation in July last year, it has transmitted over 1.2 billion kilowatt-hours of power to the East China grid.

The East China grid fully reflects the activeness of the central and local government in electric power development. It also reflects the multi-channel approach to the raising of capital in the development of power construction. In the 17.7-billion-yuan investment for power grids completed during the Seventh 5-Year Plan period, 6.5 billion yuan, or 38 percent, were from the central government; 4.2 billion, or 24 percent, were from capital collection; 1.6 billion yuan, or 9 percent, from the local government; 3.3 billion yuan, or 19 percent, were from foreign investors. Projects which have been put into operation or still under construction, such as the Nantong power station, Shidongkou substation, Beihuajiang power station, and the 500-kilovolt power transmission project between Xuzhou and Shanghai, were either financed by loans from the World Bank or by foreign investors attracted by Huaneng Power Development International Corporation.

A significant feature of the East China grid during the Seventh 5-Year Plan power construction is the large-scale and speedy completion of the project. Over the last five years, annual operational power generating capacity increased from 660,000 kilowatts in the Sixth 5-Year Plan to 1.5 million kilowatts. In 1989, operational capacity reached 2 million kilowatts. During the Seventh 5-Year Plan period, thermal power stations such as Shidongkou, Nantong, and Pingshu power stations each with generating capacity of 600,000 kilowatts or more were newly constructed and also the key power stations of Wangting, Lianbi, Minsheng, Zhenhai, and Lohe were expanded. Today, the East China grid includes five thermal power plants each with a capacity of over 1 million kilowatts (Lianbi, Xuzhou, Shidongkou, Wangting, and Zhenhai) and also five key hydroelectric power stations (Xinanjiang, Fuchunjiang, Jinshuitan, Wuchijiang, and Chenchuan) each with a generating capacity of 150,000 kilowatts or more.

The large number of medium-to-large power facilities and the 500-kilovolt transmission lines put into operation during the Seventh 5-Year Plan greatly increased the stability, reliability, and economy of operation of the East China grid. No instability or outage has occurred for the last few years. This year the situation of power generation vis-a-vis power usage, and the quality and quantity of power is best among the 10 or more years of history of operation. Not long ago the minister of energy praised the East China grid as the nation's number one in cycle pass ratio. The situation of the last few years when a limit was placed on power usage and transmission is reversed now. Power consumption broke new records continuously during summer this year with daily maximum load and daily power consumption increasing by 12.8 percent and 9.7 percent respectively over the figure for last year.

Shandong Grid Ranks First in Power Output

40100023C Jinan Shandong Provincial Service in Mandarin 2300 GMT 31 Dec 90

[Summary] In 1990, the Shandong Power Grid generated 40.02 billion kWh of electric power, ranking first among various provinces and municipalities of the country. Following the completion of the Zouxian, Shiheng, and Longkou power plants, the province in 1990 again built and put into operation the No. 8 generating unit, with an

installed capacity of 300,000 kW, of (Huangtai) power plant, the No. 4 generating unit, with an installed capacity of 210,000 kW, of the Huangdao power plant, and the No. 1 generating unit, with an installed capacity of 50,000 kW, of the Liaocheng power plant, with the total newly added capacity reaching 560,000 kW. The province's total installed capacity topped 80 million kW, the daily output of electric power generated by the power grid topped 100 million kWh, the annual electric power generated by the power grid topped 40 billion kWh, and the per-capita labor productivity of the power grid topped 60,000 yuan.

Hydropower Development at Core of Enormous Panxi Project

916B0021A Chengdu SICHUAN RIBAO in Chinese 2 Nov 90 p 1

[Article by SICHUAN RIBAO reporter Zeng Guanglu [2582 0342 4389]: "State Plans Large-Scale Development of Panxi-Liupan Shui Region To Gradually Build This Area Into an Important Energy Resource and Raw Materials Production Base Area in China"]

[Text] Officials in the State Council's Three-Line Construction Readjustment and Transformation Planning Office revealed to reporters on 1 Nov 90 that they plan to spend 50 to 60 years to gradually build the Panxi-Liupan Shui region into a major energy resource and raw materials production base area by focusing on developing the iron and steel, nonferrous metal, coal, phosphorous chemical industry, and electric power industry.

The Panxi-Liupan Shui region includes 68 counties (wards and towns) in 12 prefectures and autonomous prefectures in the three provinces of Sichuan, Yunnan, and Guizhou with a population of 28 million that covers an area of 176,000 square kilometers and accounts for 15 percent of the population and area of these three southwestern provinces. This region is extremely rich in resources and is known as the "golden triangle" of southwest China. In the area of mineral resources, this region has 72 of the 134 types of minerals already proven in China, and it has relatively abundant reserves of minerals. Panxi Vanadium-Iron-Magnetite Mine has several types of paragenetic metallic ores and is second in China in reserves. The coal at Guizhou's Liupan Shui has large reserves, a full complement of varieties, and good quality coal and is the biggest coal field in China's Jiangnan region [area south of the Chang Jiang]. Yunnan's Dongchuan Copper Mine is second largest in China in terms of reserves. There are also abundant reserves of sulfur, phosphorous, lead, zinc, and antimony as well as limestone, quartzite, barite, and other mineral resources. This region is China's champion in hydropower resources. It has 61,000MW in developable hydropower resources, 16 percent of total developable hydropower resources in China.

The state issued a call for development of resources in the Panxi-Liupan Shui region in its Seventh 5-Year Plan. While studying a national resource development plan, the State Planning Commission decided to make development of the resources of this region one of two large economic regions for primary development in China. This task was assigned to the State Council's Three-Line Construction Readjustment and Transformation Planning Office for organizing implementation.

The State Council's Three-Line Construction Office conducted joint survey research and repeated demonstrations with the related departments and commissions of the CPC Central Committee and leaders and experts in the three southwestern provinces and submitted the "Comprehensive Development Plan Report for Resources in the Panxi-Liupan Shui Region" in June 1990. The overall goals of development are to focus on the two main advantages in hydropower and minerals, make major efforts to develop agriculture and forestry, and expend efforts over 50 to 60 years to gradually build the Panzhihua-Liupan Shui region into an important energy resource and raw materials production base area with a stable and solid agricultural foundation and benign ecological environment to push this region up to advanced levels in China. The achievement of this goal is divided into short-term (1991-2000), medium-term (2001-2020), and long-term (2021-2050) phases. During the short term, the main focus is on being able to establish a framework for an energy resource and raw materials production base area. More than 10 major construction projects will begin during the short term. Examples include the Yibin-Liupan Shui segment (total length 364 kilometers) of the Inner Mongolia-Kunming Railroad, a focus on construction of Ertan Hydropower Station with an installed generating capacity of 3,300MW and doing good preparatory work on Xiangjiaba and Xiluodu cascade power stations with an installed generating capacity of 17,500MW, concentrating forces on preparations and construction work for the Panxi No 2 iron and steel base area with a yearly production capacity of 3 million tons of steel, building the new Qujing Diandong [east Yunnan] Aluminum Mill to form a yearly production capacity of 100,000 tons of aluminum during the Ninth 5-Year Plan, reinforcing preparatory work for development of the Bijie region Zhina Coal Field, and expanding the Dongchuan Tangdan Copper Mine. At the same time, there will be a corresponding reinforcement of basic agricultural facilities and forestry base areas. For this reason, the State Council's Three-Line Construction Office convened a meeting of responsible comrades from the relevant regions and departments in mid-September 90 for joint study and implementation of the requirements set forth in the "Plan".

Experts Suggest Ways To Develop Jiangsu's Low-Head Hydropower Resources

916B0021B Nanjing JIANGSU KEJI BAO in Chinese 4 Nov 90 p 1

[Article by Guang Gang [1639 0474] and Xin Sheng [2450 3932]: "Experts Propose Building a Huge Hydropower Project—China Hydropower Field, An Ideal Place: One of World's Biggest Hydropower Resources Discovered Along the Jiangsu Coast, Scientific Research To Assist in Completion: Attacks on Key Problems In World Development of Low-Head Hydropower"]

[Text] The coastal area of Subei in north Jiangsu Province contains a huge renewable energy resource that has been called "clean, inexpensive, and inexhaustible" by Ministry of Energy Resources senior engineer Pan Jiazheng [3382 1367 6927]. After developing a water turbine that is capable of utilizing this type of hydropower resource, engineer Li Minxin [2621 2404 2450],

chairman of the Lianyungang City Lianyun Region Science and Technology Commission, recently suggested the idea of building an enormous hydropower power generation project, China Hydropower Field.

According to an inspection by experts from the Nanjing Geography Institute of the Chinese Academy of Sciences, there are more than ten large seabottom sand ridges of a size seldom seen in the world located south of the mouth of Sheyang He and north of the mouth of the Chang Jiang. The tidal channels between the sand ridges are over 100 kilometers long and about 10 kilometers wide. The effects of advancing waves in the south Pacific Ocean and rotary waves in the south Huang Hai create rather large tidal differentials. Calculated at a daily rise and fall of 5 meters and an average head of 2.5 meters, this marine tidal hydropower is as much as 30,000MW, four times the total installed power generating capacity in Jiangsu during 1989.

Using hydropower conversion equipment to generate power requires a head of more than 5 meters. Developing this sort of resource would require that 90 percent of the investment be spent on dam construction. As a result, developing low-head hydropower resources without having to build dams has become a world problem. The United States and Soviet Union are now developing low-head water turbines.

Li Minxin has been studying the conversion of fluid energy for 30 years. In 1985, he developed a miniature wind-powered vehicle that uses wind to generate power. He recently installed a float on the wind-powered vehicle and the results showed that it was capable of using a large flow rate to generate low-head hydropower without a dam. Li Minxin proposed that the state install thousands of low-head water turbines in this marine region to build a huge hydropower field in China.

According to the information, China is the world leader in hydropower resources but only 5 to 6 percent has been developed, the equivalent of 900 million tons of raw coal or 450 million tons of crude oil resources flowing away unused into the sea each year.

Guangzhou Pumped-Storage Power Station Described

916B0012 Beijing SHUILI FADIAN [WATER POWER] in Chinese No 10, 12 Oct 90 pp 3-6

[Article by Luo Shaoji [5012 4801 1015], general manager of the Guangzhou Pumped-Storage Power Station Joint Venture Company: "An Introduction to Guangzhou Pumped-Storage Power Station"]

[Text] Guangzhou Pumped-Storage Power Station is located in Lutian Town, Conghua County in Guangdong Province, 90 kilometers from the Guangzhou DC power transmission line. This key power plant project is composed of upper and lower reservoir dams, a water diversion system, underground plant building, and so on. The upper and lower reservoirs are located on second-level tributaries in the upper reaches of Liuxi He and they have abundant water sources. The reservoirs are surrounded by high mountains and have excellent natural reservoir basins. The water diversion system and underground plant building are both located in thick granite, With the exception of alteration to varying degrees of the rock bodies surrounding structural fissures, the lithology is relatively homogeneous and integral. The foundations of the upper and lower reservoir dams are granite with a singular lithology and fractured structures are small in scale. The riverbed has thin alluvial strata which has been weathered to rather shallow depths. The mountains on the reservoir banks are exceptionally thick and groundwater levels are higher than the normal water storage levels, so there are no leakage problems.

The first phase project at the power station will have an installed generating capacity of 1,200MW and will install four 300MW pumped-storage generators. The generator rotation speed will be 500 rpm and the maximum head is 535 m. The overall efficiency of the power station will be 0.76 and after the power station is completed it will be connected to the Guangdong Grid via dual 500 kV output lines, so it will have obvious economic and social benefits.

To ensure safe operation of Guangdong's Daya Bay Nuclear Power Plant and meet the valley filling and peak regulation requirements of the Guangdong Grid, the state approved and agreed to construction of this power station in January 1988 and called for it to be built in synchronization with the Daya Bay Nuclear Power Plant. This power station is being constructed with joint investments by Guangdong Province and the Ministry of Energy Resources, and the Guangzhou Pumped-Storage Power Station Joint Venture Company has been established to assume responsibility for power station construction and management. It was designed by the Guangdong Province Water Resources and Electric Power Survey and Design Academy. The South China Company (a joint venture by the South China Survey and Design Academy and the Gezhouba Project Bureau) are responsible for project supervision and management. The 14th Hydropower Engineering Bureau is responsible for civil engineering and equipment installation. This article will provide a brief description of the role of this power station in the Guangdong Grid, its economic feasibility, design features, construction management, and other things.

I. The Role of the Pumped-Storage Power Station in the Guangdong Grid

In 1989, Guangdong Province as a whole had an installed electric power generating capacity of nearly 7,000MW and generated and purchased 31.5 billion kWh of electric power. There was a 30 percent shortage between supply of and demand for electric power. Small hydropower stations and thermal power plants built by counties and cities themselves accounted for 48 percent of Guangdong's installed generating capacity. The power plants which participate in grid unified dispatching

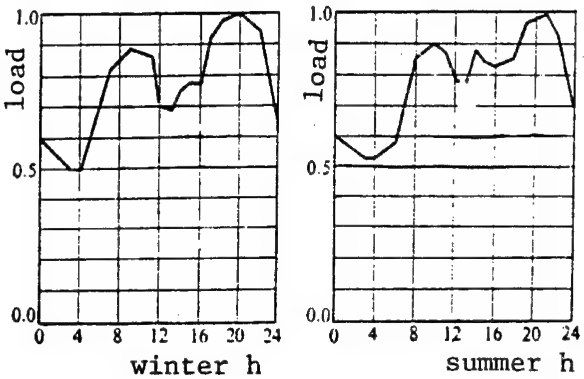

Figure 1. Typical Daily Load Curve in Guangdong Grid

accounted for just 3,600MW, of which hydropower provided 750MW or 20.8 percent and thermal power 2,850MW or 79.2 percent. Seven of the eight hydropower stations in unified dispatching have rather large reservoirs which can be used for year-round peak regulation but hydropower generated just 2.13 billion kWh of power, which is just 11.3 percent of total power output from unified dispatching hydropower and thermal power plants, while the eight unified dispatching thermal power plants accounted for 88.7 percent of power output.

In 1989, the maximum load in the Guangdong Grid was 3,138MW. The load is higher from July to September when the weather is warmer and lower during the winter. However, there is a peak-to-valley differential of 50 percent during the day, especially during the winter. Figure 1 shows a typical load curve and the load curve reveals the enormous peak regulation capacity requirements in the grid.

The measures relied upon for peak regulation in the grid during 1989 were: startup and shutdown operation of thermal power generators smaller than 50MW in unified dispatching power plants; ballast loads of up to 30 percent for the two 350MW generators at Shajue B Power Plant; ballast loads of 70 to 80 percent for other thermal power plants; purchasing electricity from Hong Kong during peak load periods, and so on. Because of the serious power shortage and inadequate peak regulation capacity in the grid, however, despite adopting the above measures, grid dispatching is still experiencing extreme difficulties and has been in a abnormal situation of throwing switches and restricting power during peak periods and being forced to shut down thermal power generators or operate at ballast loads during valleys for quite some time.

It is expected that by 1995, nuclear power (the part controlled by China) and thermal power in the Guangdong Grid will exceed 7,000MW while conventional hydropower will provide only 900MW. The maximum load in the grid at that time will be about 7,000 to 8,000MW and the valley load will be only 50 percent. Because Guangdong lacks large-scale developable hydropower resources, power from hydropower stations built in cooperation with other provinces will have to be transmitted over a distance of 1,000 km, and they will not be able to go into operation before 1995. Most of the generators to be installed in thermal power plants that will be completed in the future will have poor peak regulation capabilities and the ballast load of most will be just 20 to 30 percent. Although the design of the Daya Bay Nuclear Power Plant allows for peak regulation operation, from both the safety and economic perspectives it would be best for it to operate at basic loads and not regularly take on peak regulation tasks. If pumped-storage power stations could be placed into operation in the grid, however, they could raise valley loads and enable nuclear power plants to operate at basic loads. Large thermal power generators would not have to be shut down and their peak regulation tasks would be reduced. During high peak load periods, the grid could use stored-energy power stations for peak regulation, which would take full advantage of nuclear power and large-scale thermal power generators while at the same time reducing operation of small-scale thermal power generators to save fuel. This would provide abundant water for small-scale hydropower during the rainy season and reduce the load position of conventional hydropower, which would make them more able to meet the needs for water supplies, irrigation, water-borne transport, and other sectors of the national economy. It is apparent that construction of pumped-storage power stations is both entirely necessary and extremely urgent in dealing with the question of peak regulation in the Guangdong Grid.

II. Economic Feasibility of Guangzhou Pumped-Storage Power Station

The economic feasibility of Guangzhou Pumped-Storage Power Station can be analyzed in these six areas:

1. In consideration of conditions in the Guangdong Grid, without a pumped-storage power station, a situation would appear in which the grid might have thermal power generators but would be unable to start them up while there would still be a need to throw switches and restrict power during peak load periods. Such economic losses would inevitably be enormous.

2. Comparing stable and full output from Daya Bay Nuclear Power Plant with the peak regulation operation stipulated in the original contract and not counting the improved safety, a primary benefit, after deducting the time for repair and loading, power output from this 1,800MW power plant could be increased from the 10 billion kWh stipulated in the original contract to 12.6 billion kWh, which would be an increase of 2.6 billion kWh in valley power and the pumped-storage power station could be converted into 1.95 billion kWh of peak power. Because the repayment of the principal and interest and operating costs for the nuclear power plant have already been calculated in the contract, generating more valley power would only require nuclear fuel

expenses, nuclear waste treatment expenses, and a small amount of operating expenses. The price would be lower, which when added to the operating costs of the pumped-storage power station and repayment of the principal and interest for the capital construction investment would result in the price of its electricity being lower than the price for thermal power in Guangdong at the present time, so it would be economically feasible.

3. Compared with large-scale thermal power generator peak regulation in Guangdong, coal consumption for the 200MW generator in the Shajue A Plant at full load is 390 g/kWh. If the load is pushed to 140MW, coal consumption would rise to 413 g/kWh, an increase of 23 g/kWh. After Guangzhou Pumped-Storage Power Station is built, besides using nuclear power valley power to pump water, this also could reduce peak regulation by thermal power generators and thereby lower coal consumption.

4. Comparisons with other peak regulation measures show that if large generators than can be started up and shut down are used for newly-built thermal power, because 1 kW of this type of generator is equivalent to 1 kW of conventional generators as well as 1 kW of pumped-storage power generators, generator startup and shutdown can cause mechanical wear, so this cannot be adopted. Because the capital construction investment for building a gas-burning turbine generator is equivalent to that of a pumped-storage power station, its operating costs are far greater than pumped-storage power stations, so this also cannot be adopted.

5. In the Guangdong Grid up to 1995, the single-unit capacity of large generators in operation will be 900MW per unit for the Daya Bay Nuclear Power Plant and 350MW for large thermal power generators. The single-loop 500 kV long distance power transmission capacity from Guangxi will be 800MW, so this will require that there be sufficient accident reserve capacity near load centers to ensure safe grid operation. However, the installed generating capacity of Xinfeng Jiang Hydropower Station, the largest conventional hydropower station in Guangdong, is just 290MW and the single-unit generator capacity is just 75MW. This is far from adequate for meeting requirements, but the Guangzhou Pumped-Storage Power Station can take on the burden of this task.

6. Because of the relatively superior natural conditions at Guangzhou Pumped-Storage Power Station, this will result in relative investment savings. For the power station itself, about $160 million will be required to purchase equipment and materials from foreign countries and $200 million will be needed for civil engineering construction and compensation for inundation within China, so the total is $360 million (this refers to the basic cost of the power station and does not include low repayment interest or the 500 kV outward transmission project).

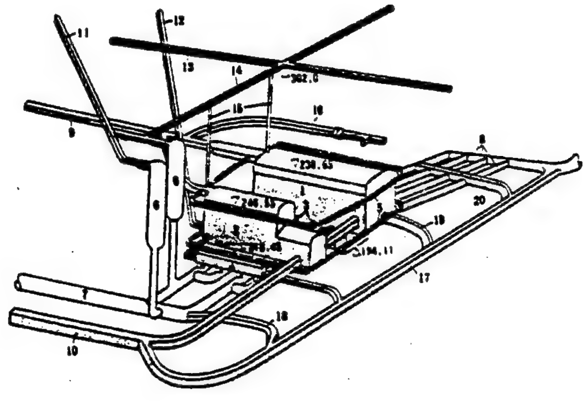

Illustration of Underground Plant Building System Configuration

Key: 1. Underground plant building 2. Main transformer switching room 3. Bus tunnel 4. Tailwater valve room 5. Water discharge channel 6. Tailwater pressure regulation wells 7. Tailwater tunnel 8. Water diversion branch pipe 9. Dual-purpose slag discharge and exhaust tunnel 10. Communication tunnel 11. Dual-purpose construction transport and ventilation tunnel 12. High-voltage electric cable tunnel 13. Main prospecting tunnel 14. Southern prospecting support tunnel 15. Vertical smoke exhaust shaft 16. High-pressure divider pipe experiment tunnel 17. No 2 construction support tunnel 18. No 3 construction support tunnel 19. No 4 construction support tunnel 20. No 5 construction support tunnel

III. Design Features

The overall configuration of the Guangzhou Pumped-Storage Power Station is illustrated on the inside of the front cover. Figures 2 and 3 show a vertical cross section and horizontal cross section of the plant building. This article will use four major technical questions to provide a brief description of its design features.

A. Dealing with the granite alteration zone

The underground plant building, water diversion tunnels, and all the other underground structures at the Guangzhou Pumped-Storage Power Station are located in Yanshan Period moderately coarse biotitic granite rock bodies. Because of geological action, the granite here has formed montmorillonite, hydromuscovite, kaolinite, chlorite, carbonate, and other alteration zones. The conversion to montmorillonite is most severe in these alteration zones and its expansion and disintegration characteristics in the presence of water mean that blocks of rock are converted into quartz granules and dilute mud soon after they are excavated. However, because the alternation zones were formed moving from below to above and from inside to outside, under closed conditions, they are still relatively strong, so the stability of the surrounding rock can be maintained by closing

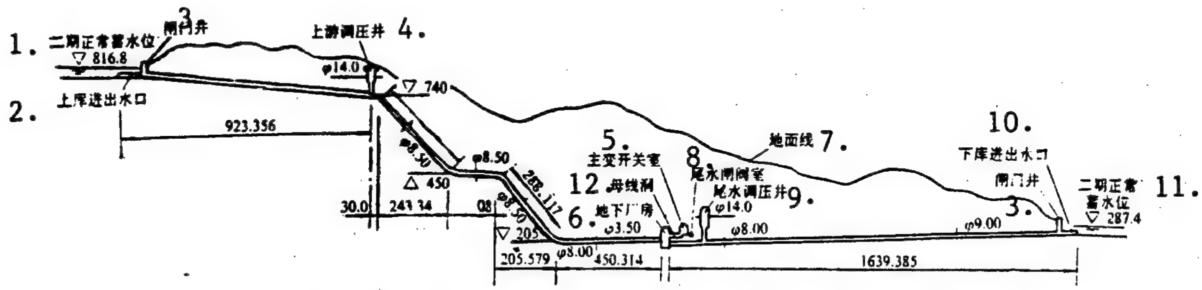

Figure 2. Vertical Cross-Section of Water Diversion and Plant Building Systems

Key: 1. Normal water storage level in second phase 2. Upper reservoir water intake and outlet 3. Lock well 4. Upstream pressure regulation well 5. Main transformer switching room 6. Underground plant building 7. Ground surface line 8. Tailwater valve room 9. Tailwater pressure regulation well 10. Lower reservoir water intake and outlet 11. Normal water storage level in second phase 12. Bus tunnel

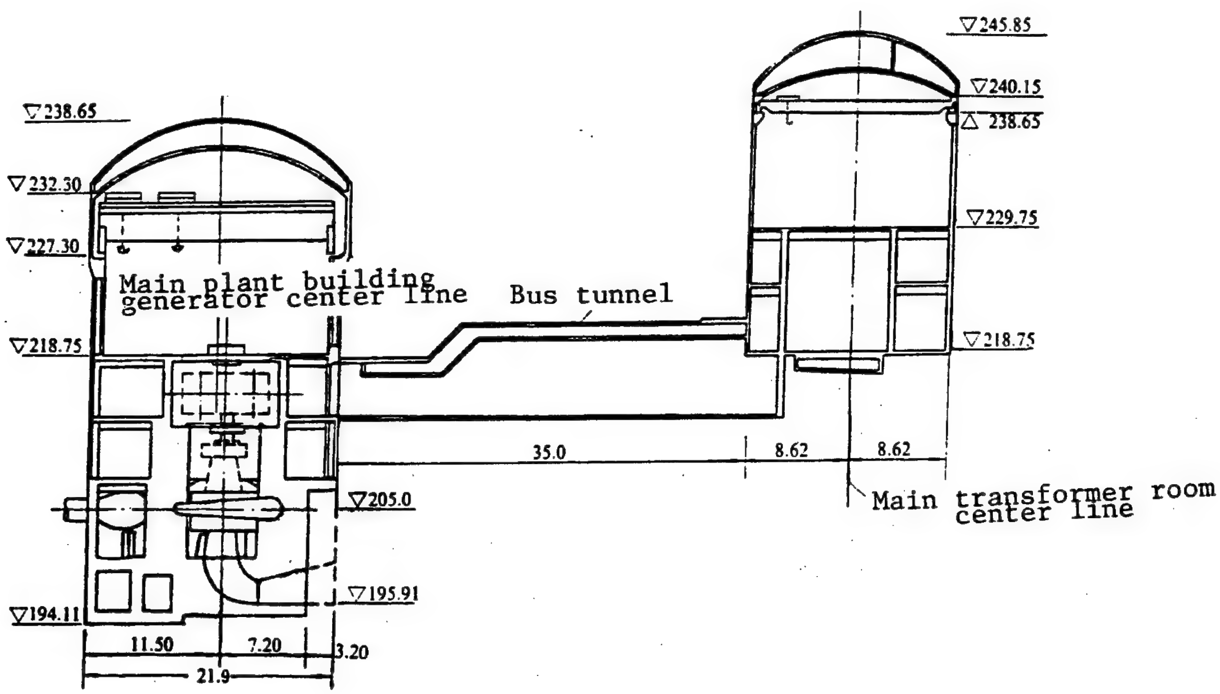

Figure 3. Cross-Section of Main Plant Building and Main Transformer Room

them immediately after they are excavated. The countermeasures taken in this project were: careful geological surveys and analysis work, excavating horizontal prospecting tunnels over 2 km long, using the horizontal tunnels for control, and selecting sections with fewer alteration zones for placement of the underground structures (especially the plant building and high-pressure divider pipes); for categories III and IV surrounding rock which have more alteration zones, immediately spraying shotcrete supports after excavation for construction, and so on. Excavation has now been completed for most of the underground projects at the power station. Practice has proven that the situation with the rock bodies at the main plant building which has a 22 m span is excellent, that the shift in position of the top arches is within the expected range, and that the top arches after roof bolt support are stable. Construction of the rock wall hoist boom is also complete.

B. The program with one tunnel and four generators

There are few examples in China of the arrangement adopted at this power station in which one tunnel is used to supply water to four generators, but foreign countries have experience. The concern in this type of program is that in the event of an accident in the water transmission

system, the result may be a power outage at the entire plant, and a full-plant power outage would be hard for the power grid to bear. After careful analysis, however, it is felt that the probability of an accident in the water transmission system, particularly one in the civil engineering project, is very low. The technical levels of the main valves are relatively high and accidents would occur in very few of them. Daya Bay Nuclear Power Plant shuts down its generators for more than 2 months each year for fuel replacement and maintenance, and this would provide time for maintenance at Guangzhou Pumped-Storage Power Station. In the unlikely event of a full-plant power outage, the Guangdong Grid, Hong Kong Grid, and Guangxi Grids would already have been interconnected at that time and would have a very large capacity, so they would have the capacity to deal with this. The main consideration is that this power station will be very quickly expanded to 2,400MW and at that time it would not have one tunnel for four generators but instead would have two tunnels for eight generators. Moreover, there could be a 15 percent savings in water diversion project costs for one tunnel and four generators compared to two tunnels and four generators. In the balance, the program for one tunnel and four generators was chosen.

C. Steel-reinforced concrete divider pipes

The hydrodynamic pressure on the divider pipes upstream from the power station would be 725 m. In these conditions, there are few examples in China of using steel-reinforced concrete linings instead of steel sleeves. Given the difficulty in constructing steel divider pipes and the rather large investment required, and the fact that the divider pipes at the power station are 450 m beneath the ground in integral rock bodies, all the measured ground stresses would be greater than the hydrostatic pressures inside the pipes. Thus, it is feasible to take full advantage of the favorable conditions of the surrounding rock to bear the internal water pressures and reduce the cost of the linings. With financial support from the Asian Development Bank, we recruited the United State's (Hazha) Company to take on the design of this project and train Chinese technical personnel. The results of the design show that with a lining thickness of 0.6 m, using φ primary circular rods at a spacing of 20 cm and reinforcing them locally with φ 36 and a spacing of 17 cm at fork locations, and having the surrounding rock bear 69 percent of the internal water pressure, the radial deformation of the steel rods and surrounding rock would be only 1 to 2 mm, so the strength of the steel rods would be far from playing a role, but this would restrict the expansion of cracks in the concrete. Grouting would be used mainly for the purposes of reinforcing the strength of the surrounding rock and preventing leaks and would be given prestress treatment.

D. Hydraulic system

Because of terrain limitations, the distance between the upstream and downstream pressure regulation wells (along the length of the pipeline) at the power station would be 1,411 m. This is rather uncommon both in China and foreign countries. To ensure hydraulic stability at the power station and provide relatively optimum regulation guarantee properties, after careful calculations by famous Chinese experts and France's EDF Company Design Academy, a program with one upstream pressure regulation well and two downstream pressure regulation wells was adopted. The upstream and downstream pressure regulation wells would be 14 m in diameter and all would have an upper chamber and resistance holes. Analysis of the parameters of the water pumps and water turbines shows that their hydraulic stability, attenuation, and surging can all meet requirements.

IV. Construction and Management

In November 1986, the feasibility research report for the power station was completed and after being examined and approved by the Ministry of Water Resources and Electric Power and passing evaluation by the China International Engineering Consulting Company, the Ministry of Water Resources and Electric Power examined the preliminary design for the power station in May 1988. The examined and approved construction schedule for the power station was 6 years and the schedule for the first generator to go into operation was 5 years. Construction of the power station formally began in July 1988 and the first generator will begin producing electricity in June 1993. The attached table [not reproduced] shows the project progress.

Guangzhou Pumped-Storage Power Station is the first large pumped-storage power station to be built under China's new construction management system and using bid solicitation. The Guangzhou Pumped-Storage Power Station Joint Venture Company, the owner, has property rights over the power station and is responsible for power station operation and management, for raising capital from all the parties in the joint venture, and for repaying the loans and bonds. During construction, the joint venture company is directly responsible for power station construction management and command. The company established subsidiary project, equipment, planning and finance, and overall departments and a power station reserve office and dispatched an on-site command department at the construction site to take responsibility over work to coordinate the various units involved in power station construction and local governments and the masses. The joint venture company also recruited a project supervision and management unit with rather strong technical forces as its on-site representative to supervise the progress, quality, safety, and finances in the project. The project supervision and management unit has the authority to issue construction start orders and construction stop orders to the businesses with contractual responsibility for construction, and it is responsible for inspecting the economic accounts of the businesses with contractual responsibility for construction. They assist the joint venture

company in the entire process of soliciting bids, scrutinizing the contractual responsibility contracts, and various other items of work. Besides supervising and managing the construction units, they also supervise the design units and can offer their own views concerning the design programs based on their own experience for decision making by the joint venture company. The construction charts provided by the design units must first of all pass through project supervision, management, and inspection and be supplied to the construction units by the project supervision and management units. To reinforce relationships among the various units, the joint venture company holds senior engineer conferences each month in the three areas of design, supervision and management, and construction to coordinate technical questions during the process of project construction. As for comparison and selection of electromechanical equipment purchased from international sources, the joint venture company has direct responsibility. Electromechanical supervision and management are involved only in work in the areas of contract implementation and electromechanical equipment installation.

Guangzhou Pumped-Storage Power Station is the first high head and large capacity pumped-storage power station built in China. To immediately and correctly resolve major technical problems in project construction, besides relying on the Central Water Resources and Hydropower Planning and Design Academy for inspecting the design, the joint venture company has also recruited renowned Chinese hydropower experts to form a high-level consulting group that convenes meetings on an irregular schedule, discusses technical decisions made by the joint venture company, and provides advisory opinions. The company has recruited experts from the French Electric Power Company to assume responsibility over configuration of the power station, hydraulic transition process calculations, geological, progress, and other special advice and to be responsible for training power station operating personnel and operation and management of the power station during the initial stages. They have recruited Swedish energy experts for consulting on designs and monitoring of underground projects. The Asian Development Bank has recruited the United States (Hazha) Company to take responsibility for the high head steel reinforced concrete divider pipe designs and training Chinese personnel. In addition, Australia's Snow Mountain Company has experts at the construction site to assist in the work.

This construction management model is a new attempt following China's opening up and reform that integrates the Chinese and international situations. We will strive to resolve all problems that appear during progress and perfect them.

At present, construction is proceeding feverishly at Guangzhou Pumped-Storage Power Station and we are striving to place it into operation simultaneously with Daya Bay Nuclear Power Plant to alleviate the severe shortage of peak regulation capacity in the Guangdong Grid as much as possible. Construction, design, and other units at the power station are cooperating closely to overcome all types of difficulties and are struggling to achieve the goal of generating power at the Guangzhou Pumped-Storage Power Station one-half year ahead of schedule.

Qinghai To Increase Hydropower Capacity

OW0301183591 Beijing XINHUA in English 1533 GMT 3 Jan 91

[Excerpt] Xining, January 3 (XINHUA)—Qinhai Province has drafted a plan to increase its installed hydroelectric power capacity from the current 1.37 million kilowatts to over 5.5 million kilowatts by the year 2000.

In addition to the Longyangxia Hydroelectric Power Station, which has a generating capacity of 1.28 million kilowatts, the province plans to build five large hydroelectric power stations with a combined generating capacity of 9.5 million kilowatts. A provincial official said that the power stations would be built on the Yellow River. The official said that of the five, the two million kilowatt Lijiaxia and the 1.5 million kilowatt Gongboxia Power Stations are under construction and are expected to be put into operation by the year 2000. First phase construction of the other three stations will be completed during the Ninth 5-Year Plan period (1996-2000).[passage omitted]

Work Completed on Shijingshan Power Plant

916B0003B Beijing RENMIN RIBAO in Chinese 18 Sep 90 p 1

[Article by Zhang Chaowen [1728 6389 2429]: "Shijingshan Fossil-Fired Power Plant Construction Completed"]

[Text] 17 September (NCNA)—Premier Li Peng today stated that China's electric power enterprises must increase their yield of economic benefits, conserve energy, and make a contribution to socialist construction.

In a speech at the ribbon-cutting ceremony marking the completion of construction on the Shijingshan fossil-fired power plant in Beijing today, Premier Li said, "As a former official of the North China Power Industry Management Office, as one of the earliest participants in the Shijingshan Power Plant project, and as an activist, I am very happy today to see the plant fully commissioned and to meet many old comrades and friends who were at my side in the struggle."

Li Peng stated that "In the course of socialist modernization, China must implement the great strategic objective of quadrupling output value by the end of the century and must build even more power plants. We must increase economic benefits and conserve energy. We must build more fossil-fired power plants."

He continued: "The Shijingshan plant is an old plant with glorious traditions, with a glorious history of self-reliance, arduous struggle, scientific plant management, and an emphasis on safety. I hope that the comrades at the plant will continue to bring the good traditions and good work style into play, will manage and operate the plant effectively and will make an even greater contribution to the construction of the capital city and to supplying it safely with power."

The Shijingshan Power Plant was first built in 1919, with a generating capacity of 55,000 kW. It was the largest generating plant in the Beijing area before the founding of the present regime. In the 1950's it was expanded and its capacity was doubled, but it was still unable to meet all of Beijing's heat and power needs. In 1983, with State Council approval, the State Energy Investment Company, Beijing City and the Huaneng Power Company jointly invested in the reconstruction of the old plant as a fossil-fired unit with three 200,000-kW power generating units. Comrade Li Peng, who worked in the North China Power Industry Management Office for many years, attached especial importance to this project, and many times inspected it and provided guidance. He personally decided to solicit bids on the project in order to accelerate construction. When the plant is completed, it will make an important contribution to alleviating heat and power shortages in the capital.

After the ribbon was cut, Premier Li inspected the three generator shops and the control room. He questioned the plant management in detail about the construction and operation of the plant and greeted new and old workers on the site, encouraging them to manage and use the new power plant effectively.

CCP Central Committee Political Office member and secretary of the Beijing Municipal Committee Li Ximing [2621 6932 6900], who worked at Shijingshan Power Plant for 26 years, also spoke at the ribbon-cutting ceremony, exhorting the employees of the power plant to keep the generating units operating normally and to provide power and heat to the capital.

State Council member and Beijing Mayor Chen Xitong [7115 1585 0681] and Minister of Energy Huang Yicheng [7806 3015 6134] also took part in today's ribbon cutting ceremony.

Early Work on Changshu Plant Ahead of Schedule

916N0003C Shanghai JIEFANG RIBAO in Chinese 13 Jul 90 p 3

[Article: "Pile-Driving Work for Changshu Power Plant Completed Ahead of Schedule"]

[Text] The pile-driving work for the main building at the Changshu Power Plant, a key state project, was completed ahead of schedule.

The Baogang [text garbled] 10 smelting company, which was in charge of this work, was the first construction enterprise to receive a state quality management award. In this project it made thorough use of its own advantages, did everything possible to maximize available working time, strove for speed, assured quality, and achieved all-round excellence; in the end, it accomplished its task 19 days ahead of schedule, meeting construction specifications with a 100 percent superior rating.

After the Changshu power plant is completed and commissioned, its annual generating capacity will be 13.2 billion kWh, equivalent to 3 times the entire national generating capacity before liberation.

Construction Stepped Up on Sichuan's Kaixian Plant

916B0003A Chengdu SICHUAN RIBAO in Chinese 15 Aug 90 p 1

[Article: "Pace Stepped Up in Construction of Kaixian Power Plant"]

[Text] With the support and cooperation of the local government and the people, and with all-out efforts by the builders, the pace of construction has been stepped up on the Kaixian power plant project, one of the key state projects in support of poor areas. By the end of June, the cumulative amount of work done on the power generation facilities and the transmission and transformer facilities represented a total of 62.65 million

yuan of the project investment. By the end of the year, the No 1 unit will be in the partial test operation stage, and vigorous efforts are being made to incorporate it into the power grid in the first quarter of next year [1991].

The Kaixian power plant is located on the banks of the Dongli River, 14 km from the county seat. The project consists of two 50,000-kW coal-fired units and involves a total investment of more than 160 million yuan. Since the formal startup of the project on 20 September 1988, the province electric power office, the province No 1 electric power construction company and Kaixian County have all assigned personnel with construction experience to work on it. The local government and the people are vigorously supporting construction and do not begrudge the use of valuable land as a power plant site; they have provided materials, daily necessities, and local manpower to assure its success.

The builders have overcome difficulty after difficulty, working steadily around the clock. In the pouring of concrete for the central pumping station, undertaken by the province No 1 power construction company, wheelbarrows were used to transport the materials. More than 470 cubic meters of concrete was poured at one time in order to guarantee the quality of the project. At the boiler unit installation site, the steel framing and plates often are heated to 60 or 70 degrees Celsius under the hot sun, but the workers still remain steadfastly at their posts.

The site of the main building has been made waterproof and the concrete for the steam equipment platforms is being poured. The earth moving for the coal transport system is 60 percent complete, and the chemical water treatment system is being installed. The 120-meter reinforced concrete smokestack is nearly completed. Installation of the main 220-ton-per-hour boiler is now at peak intensity.

Heilongjiang Mines Set for Expansion

40100021A Beijing CHINA DAILY (Business Weekly) in English 10 Dec 90 p 2

[Article by staff reporter Huang Xiang: "Coal Mines Set for Expansion"]

[Text] China's third largest coal-producing province, boosted by the recent discovery of substantial reserves around old mines, is planning to install new mine shafts and power generators over the next few years.

Heilongjiang Province in Northeast China is expecting, in this way, to increase the production capacity of four of its main coal mines by 7 million tons a year by the end of 1995.

Last year the four mines turned out more than 50 million tons of coal, or 10 per cent of the total turned out by China's 618 State-run mines.

Sources from the Ministry of Energy Resources said the plan to install new mine shafts and power generators was based on the fact that "an encouraging amount of newly-determined deposits" had been discovered around established mining sites in the east of Heilongjiang.

Proven reserves in and around the four mines had now reached 17.66 billion tons, six billion tons up on the 1987 figure.

The sources said the extra coal produced over the next five years would be used to generate electricity at plants built near those mines instead of being transported out of the province.

In 1988, they said, Heilongjiang supplied other provinces with more than 20 million tons of coal, 4.6 million tons of which went to the neighbouring provinces of Liaoning and Jilin for electric power generation purposes.

Since 1986, Heilongjiang had been forced to turn to other provinces for 1.3 billion kilowatt hours of power each year.

The installation of coal-fired generators near mining sites was believed to be a solution to this costly problem, they said.

A ministry official said that construction of three mouth-pit power plants in Jixi, Hegang and Qitaishan was currently being considered.

Oil Output Seen Rising Over Next Decade

40200027a Beijing CHINA DAILY in English 29 Dec 90 p 1

[Article by staff reporter Xiao Xu]

[Text] Oil officials say prospects for China's oil industry in the next 10 years are optimistic.

The nation's oil output is expected to increase 36.6 percent from the 1981 figures to reach 138.3 million tons of crude oil by the end of this year, said Zhou Yongkang, deputy manager of the China National Oil and Gas Corporation.

He told reporters on Thursday that 137 million tons of this year's total production would come from oilfields across the country and 1.3 million tons from offshore oilfields.

China's three major oilfields will see a slight increase in production despite shortages of funds and natural disasters.

The output of the Daqing Oilfield is expected to reach 53.6 million tons this year. The Shengli Oilfield will turn out 33.5 million tons of oil and the Liaohe Oilfield will produce 13.6 million tons.

Zhou said Daqing, China's largest oilfield whose output accounts for 40 percent of the country's total production, has already maintained its output at around 50 million tons for 15 years and will be able to keep to this production level for another five years.

He said the achievement can be attributed to the advanced technology used in exploration and oilfield development.

China has turned out a total of 1.2 billion tons of crude oil in the past 10 years, 1.5 times that of the 1971-1980 period.

The estimated oil reserves in thef same period has increased 1.7 times over the previous decade.

The new oil production capacity of 130 million tons has been set up in the oilfields of Daqing, Shengli, Liaohe, Dagang, and North China.

Zhang Wenshao, deputy director of the corporation's exploration department, said the corporation has made "three breakthroughs" in exploring for oil in the northwest—in the Tarim Basin, the Turpan-Hami Basin, and in the Shaanxi-Gansu-Ningxia area.

First Crude From Tarim Shipped to Refineries

40100023B Beijing XINHUA in English 0207 GMT 1 Jan 91

[Text] Beijing, January 1 (XINHUA)—The first 1,800 tons of crude oil tapped in Tarim Basin in Xinjiang Urgur Autonomous Region began to be transported by railway out to refineries today.

According to China National Petroleum Corporation, China produced 990,000 tons of crude oil in Tarim Basin in 1990.

Since April of 1989 when the corporation amassed a large contingent of oil experts and workers to start oil exploration in the vast desert of Tarim Basin, it has proven a certain number of oil reserves and controlled a large area of oil-bearing structures.

In June 1989, the corporation decided to begin a trial production in an exploration area in the basin in order to accumulate experiences in tapping oil by deep wells.

With the development of oil exploration in the basin, the daily output of crude oil increased too rapidly to be transported by tank cars. Now the corporation has built a railway station for oil load and transport and three 5,000-cubic-meter oil storage tanks in Korla in southern Xinjiang.

Zhou Yongkang, vice-president of China National Petroleum Corporation, told XINHUA that the current results of oil exploration in Tarim Basin showed that he is very optimistic about finding several large, high-yield oil fields.

New Exploration in 10 Key Areas Slated

40100023A Beijing XINHUA Domestic Service in Chinese 1429 GMT 11 Jan 91

[Article by reporter Zhu Youdi [2612 1635 2769]]

[Text] Beijing, 11 Jan (XINHUA)—This reporter learned from the Ministry of Geology and Mineral Resources that China will explore for new oil and gas deposits in 10 key areas throughout the country during the Eighth Five-Year Plan period. The major emphasis will be placed on new areas, territories, types, and depths for new oil and gas fields with advanced science and technology.

These 10 areas are as follows: The Songliao Basin; the North China Region; the East China Sea Continental Shelf Basin; the Sichuan Basin; the Nanhai Sea Waters; the lower reaches of the Chang Jiang overlapping Jiangsu, Zhejiang, and Anhui Provinces; the middle reaches of the Chang Jiang where Hunan and Hubei Provinces are situated; the Ordos Basin situated over the borders of Inner Mongolia Autonomous Region, Shaanxi, Gansu, and Shanxi Provinces; and the Lunpo-la [0243 0980 2139] and the Baingoin Basins on the North Tibetan Plateau.

At present, China's confirmed oil and gas resources have dropped somewhat and replacement reserves are in short supply. These 10 key areas for oil and gas exploration were designated based on the new understanding and thinking for mineral exploration, which was formed during the Seventh Five-Year Plan period. This thinking takes China's urgent demand for oil and natural gas for economic development and the estimate of the trend of

development for China's oil and gas resources in the next 10 years into consideration. The Ministry of Geology and Mineral Resources proposed: It is necessary to make efforts to discover large and medium-sized oil and gas fields in the Tarim Basin and East China Sea; greatly increase the efforts to prospect for natural gas, including coal gas; work hard to make new progress in the shallow-layer territories and the small basins in the central and eastern areas; and do a good job in rolling prospecting and development in the small oil and gas fields with complicated geological conditions.

The Tarim Basin is the only large oil-bearing basin on land in China, which has not been explored much. At present, localities to the north of the Tarim River such as Xayar, Akkum, Akkol, and central Tarim discovered a number of high-yielding oil and gas wells after successive drillings; verified and controlled a certain volume of deposits; started to engage in large-scale drilling; and accelerated the process of exploring for oil and gas resources for the replacement zones in the west. China will begin to investigate and study the whole basin in order to discover new fields while expanding the achievements in northern Tarim during the Eighth Five-Year Plan period. The East China Sea is China's only sea area not yet open to the outside world. The volume of its resources is expected to be considerable. Part of the East China Sea Basin's structure is highly developed, scattered in groups and zones. This is conducive to discovering oil and gas in the East China Sea. China will regard the Xihu Depression as a major oil and gas exploration zone in order to find large and medium-sized oil and gas fields during the Eighth Five-Year Plan period.

The Ministry of Geology and Mineral Resources revealed that the Songliao Basin is an old oil and gas zone, which has been explored numerous times. At present, some important breakthroughs were made and two oil and gas fields and a number of structures with oil and gas were discovered. Further explorations will be conducted in the southern part of the basin in the future. China will place the emphasis of exploring for natural gas on Sichuan and Ordos Basins in order to create conditions for our country to be among the major gas-producing countries in the world. Expert analysis revealed that the prospects of oil and gas production in Chang Jiang, the quasi-platforms in South China, and the marine territory cannot be disregarded. The comprehensive approach for evaluating and selecting oil and gas zones in the middle and lower reaches of the Chang Jiang as well as the efforts to tackle major difficulties in prospecting technics will create new situations for oil and gas discoveries in the economically developed regions of China. Exploring for oil and gas on the Lun-po-la and Baingoin Basins averages about 4,500 meters above sea level and is expected to make new contributions to Tibet's economic development.

Development Strategy for Oil and Gas Resources

916B0029A Beijing ZHONGGUO DIZHI [CHINA GEOLOGY] in Chinese No 12, Dec 90 pp 10-12

[Article by Xie Qiuyuan [6200 4428 0337], Ministry of Geology and Mineral Resources]

[Text] China's main energy production and consumption resource is coal. The Chinese Energy Resource Research Commission estimates that by the year 2000 coal will still be 77 percent of the consumption structure, but oil and gas requirements and dependency will also be considerable. As the economy develops, the degree of reliance on oil and gas will continue to increase, and will continue to represent about 20 percent of the primary energy production and consumption structure. According to the (China Geology Report, 1990 March 9), China plans, by the year 2000, to have an annual oil production of 200 million metric tons, and an annual gas production of 30 billion cubic meters. This means that from 1989 to 2000, 1.25 billion metric tons of new annual increases in proven oil reserves will be needed, and 1.49 trillion cubic meters of new increases in proven gas reserves will be needed annually, and that will be a tough order to fill. This writer believes that if the ratio of reserves to exploitation is adjusted at the old oil fields an annual new increase of proven reserves can be 700 million tons (based on present actual annual increases this figure is possible), and it can meet the minimum needs in oil production by the year 2000. According to 1987 estimates from the U.S. Department of Energy, the ratio of world oil reserves to exploitation is 20:1; for the U.S. it is 6:1, and in the Soviet Union it is 13:1. As a general rule the ratio of reserves to exploitation is initially high, but tends to come down later on. China's eastern oil fields are in the prospecting stage, or in the mid or late-term exploitation stages, the basic facilities at the oil fields are already established, the ratio between reserves and exploitation can be reduced, and the reserves needed to maintain production volume can still be maintained.

Generally speaking, China's oil and gas geology workers made outstanding achievements over the past 40 years, and the major discoveries made they've made in recent years, particularly in Xinjiang and off-shore, forecast a return performance by China's oil and gas industry. China's oil and gas production volume stands fifth in the world, and has bright prospects, but China also must face a grim reality; its proven reserves are seriously insufficient. There can be no delay in starting the survey and prospecting for new reserves that are going to be needed before exploitation of oil and gas can be further developed effectively. Objective analysis of geological conditions show there are sufficient oil and gas resources to assure growth in reserves. China's yet undiscovered oil and gas resources are still very rich. According to a 1987 report in (China Oil & Gas Report), the mining and petroleum ministries correctly forecast that the total oil resources in China were 61.4 to 78.7 billion metric tons, and total gas resources were 26 to 33 trillion square

meters. All of the proven oil and gas reserves established over the past 40 years are only a small portion of China's total resources. The resource potential is still vast; first, two-thirds of all of the sedimentary rock regions in China still await prospecting; second, the hidden resources of the cenozoic basins in the eastern regions await further excavation; third, resources in the northeast, which make up one-fourth of the total resources in the country, have not been explored as extensively as those of the east, and are awaiting discovery; fourth, the off-shore continental shelf is an area of 1.3 million square kilometers which contains 11 primary off-shore basins, but it has been little explored, and it too awaits development; fifth, paleozoic sedimentary areas off-shore also await further exploration. Further investigation of undiscovered oil and gas resources to locate proven reserves requires expending great efforts, sufficient time, and very large investments. As good prospects for oil and gas present themselves the difficult challenges must be taken on. The basic factors limiting growth of China's oil and gas reserves are: growth of oil reserves is directly affected by the fact that preliminary geologic work is not keeping up with developments in oil production, and by serious shortages in geologic prospecting funds. Over the last 30 years geologic survey prior to petroleum exploitation has enjoyed many successes, but overall, the exploration processes have been uneven, many areas have not been thoroughly explored, preliminary geology work has not kept with developments in oil production, and for ten years now, no new oil regions have been prepared that can replace the old oil fields. In the period since the Cultural Revolution, the geologic survey and prospecting that was done before exploitation and search for reserves has been ignored, and very few have been revisited for opening up new regions (basins). Recent new reserves are mainly unearthed and expanded in old oil regions (with great success), not many new oil regions have been found, and when they have, nothing has come of them because too little work has been done. Preliminary geological survey and prospecting is crucial, if resources are to be transformed into reserves. For example, before Daqing was found the Ministry of Geology had carried out a thorough geologic survey of the Songliao Basin, drilled nearly 1,000 exploratory wells, completed a 1:2,000,000 scale comprehensive geophysical survey, made a preliminary clarification of the geological structure, and primary structure of the basin (including Daqing Changyuan), and the first successful well site was selected on a reliable geological basis. After that, the Ministry of Petroleum again spent 10 years before completing the main geologic reserve. In constructing an oil field, 5 to 10 years of geologic survey must be done before discovery, and another 5 to 10 years are needed after discovery to define the reserve and put it into production. There are very few reserve bases now that can quickly replace old oil regions, and few that can quickly be elevated to proven controlled reserves. In the forthcoming 5 to 10 years China will feel the effects of having ignored preliminary geologic work. If this situation is not changed, development of oil production will be very difficult. Shortage of funds is a big problem. Mining departments are receiving limited prospecting funds, and that limits new efforts, and there is no incentive to increase efforts. To increase petroleum geology surveying and prospecting more investments must be made, and greater efforts must be organized.

It is the view of this writer that the way to find new oil reserves is to take the following steps: 1. Excavate, expand, and drill deeper into developed oil and gas producing regions. 2. The most effective way to find new reserves is to open up new prospecting areas, and speed up survey and prospecting in the northwest (Junggar, Tarim, and Ordos basins). 3. Expand inland oil fields to the sea coast (such as Shengli oil field to Laizhou Bay, Dagang oil field to Bohai Gulf, Liaohe oil field to Liaodong Bay). That would have good results. 4. Encouraging off-shore oil and gas prospecting (independent, and Sino-foreign joint ventures) would be a way to ensure growth of oil reserves. 5. Exploit new technology, and prospecting methods to reduce prospecting time. 6. Improve methods of opening up oil fields, raise the rate of exploitation, and develop heavy oil. 7. Focus on prospecting and development of natural gas to alleviate the pressure on petroleum. 8. Open up channels to increase investments in oil prospecting.

During the next 10 years, developing new oil and gas reserves will primarily be done in the old oil regions, by opening up new areas, and by developing off-shore areas within the four established oil and gas regions. They are:

The eastern oil region. China's five primary oil producing basins in this region are Songliao, Huabei (including Liaohe, and the Bohai Gulf), Subei, Jianghan, and Nanxiang. They produce 90 per cent of the nations crude oil. They are mid cenozoic oil and gas bearing basins, and proven oil reserves there are not yet one-third of the predicted volume of resources in the region. Huabei, Subei, and Jianghan have rich resources in the paleozoic layer beneath the cenozoic layer. In these basins the sub-level mid cenozoic single-fractured, and double-fractured depressions both possess conditions for oil reserves, only a part of which have been explored and developed, or are in the process of being explored. There are vast areas yet to be explored. In addition, in south Huabei there are oil and gas discovery wells in the Yilan and Yitong basins. Erlian basin has already yielded an oil field, therefore oil and gas bearing regions in the East will not only still be China's main oil producing base in this century, but it will be the main region for finding new oil reserves.

Northwest oil and gas region. The Ordos and Jiuquan basins were the first two oil basins to be opened up in China. Qaidam and Junggar are two others that were the earliest to be opened up since the revolution. Although they are listed as in production, prospecting, overall, was not done thoroughly, and there are areas, such as the Paleozoic zone in the Ordos basin, eastern Junggar, and the Turpan Basin that are just now under exploration. Although it is the area of greatest potential for oil and gas resources in China, proven oil reserves there still are not

10 per cent of the total volume of resources. The volume of reserves in the mid cenozoic zone in the Ordos Basin grows with each year, and the carbonate rocks of the paleozoic sea have yielded commercially valuable natural gas. In the eastern Junggar Basin a new oil region was discovered. It is estimated that reserves will exceed that of oil fields already developed in the eastern area. Tarim Basin prospecting continually yields new finds. The northwest oil and gas region is an important land region for China that in this century will produce new reserves of oil and gas, and will bring new production volumes.

Oil and gas areas on the continental shelf. Exploration of the basins along China's continental shelf has been going on for over 10 years, and there has already been a series of important discoveries. Independent prospecting has been carried out in the East China Sea, and Liaodong Bay; there are 17 industrial oil and gas wells, six with confirmed oil and gas structures. In addition to that, as reforms unfolded, contracts were signed with foreign oil corporations for exploration and development of basins in the Bohai Gulf, South Yellow Sea, Pearl River mouth, Qiong River mouth, southeast Qiong, Yinggehai, and Beibu Wan. By 1987, 130 exploratory wells were drilled from 94 platforms, and they produced 46 oil and gas bearing wells, 26 with proven oil- and gas-bearing structures. Together with the independently managed areas, they prove the existence of several large and medium oil and gas rich areas. There are 28 wells in the Bohai Gulf, 10 at Chengbei (Sino-Japanese cooperation), and 3 at Weizhou (Sino-French cooperation) which have already formally gone into production, and there are several other oil and gas fields that are expected to be opened up soon. Thus have off-shore area oil and gas reserves, having already gone into production, demonstrated their utility, and the prospecting efforts just underway present prospects that are cause for optimism. Pushing on with prospecting not only makes possible the discovery of large oil and gas fields, but they can even become China's new oil and gas producing areas within this century.

Southern oil and gas regions, and natural gas areas. The paleozoic carbonate rock areas south of the Yangtze River in Sichuan are the main natural gas (dry-gas strata) producing areas in China, producing, as they do, half of all natural gas produced in the country. Future growth in natural gas reserves (dry-gas strata) and production volumes will take place in the Sichuan basin. The middle and lower Yangtze basins, and the Yunnan-Guizhou-Guangxi region which are now under exploration are also certain to yield reserves. Beyond that, the Baise Basin, as representative of several small basins, can also bring proven reserves. The major development in the southern oil- and gas-bearing region will mainly be in the growth of its natural gas reserves.

About 90 percent of the natural gas resources are distributed in the eight basins of the south sea and east sea areas, Tarim, Sichuan, and Huabei (Bohai Gulf), Ordos, Junggar, and Songliao. Prospecting and opening up natural gas resources will be done in varied areas. In the marine sedimentary rock areas of the North, besides the famous cenozoic carbonate (Sinian system) bedrock oil pools of the Renqiu oil fields, there are other parts rich in natural gas. Natural gas resources in carbonate rock areas of Tarim, Ordos, and Huabei basins, are even more worthy of attention than the marine sedimentary rock areas of the South. Exploration for natural gas in those basins has just begun, and has already been effective. The most hopeful high producing gas field is the in the Tarim Basin. In the coming years it is expected there will be a number of proven reserves, and the first group of gas fields will be established there.

China's coal gas potential is very great, the resources being mainly distributed in the Huabei, Ordos, Sichuan, East China Sea, South China Sea, Songliao, and northwest basins. A number of coal gas fields have been discovered in the past few years, and that will continue, and it will become an important factor in the development of China's natural gas reserves.

Shallow strata natural gas is another subject, including biogas, and secondary gas (originally deep, collected in shallow strata). In several basins in eastern China a fair number of gas fields of this type have been found at Songliao Honggangzi, Subei Liuzhuang, Huabei Gudao, and lower Liaohe. Because there are sufficient deep gas resources in the East, and there are many ruptures, there are good shallow strata reserves, and as exploration intensifies it is very likely that discovery of groups of shallow strata pools will continue. At Qaidam Basin the fourth recorded high yield biogas pool has been discovered. Shallow strata gas pools are easy to find and develop, they are rich resources, and they have great development prospects.

The potential of China's natural gas resources is great, but they are rather difficult to find, and proven reserves are few. Every means should be taken to increase the discovery of gas fields, and to assure continued growth in the proportion of natural gas in China's energy structure, and to steadily secure for natural gas an ever more prominent place in China's resource strategy. It is China's strategic resource of the future.

Big Gas Field Discovered in Shaanxi-Gansu-Ningxia Basin

916B0025B Beijing RENMIN RIBAO in Chinese 29 Nov 90 p 1

[Article by staff reporters Su Minsheng and Cui Chengwu]

[Text] Xian, 28 Nov, New China News Agency—Following the discovery six years ago of the Xinfu and Dongsheng coal fields in the area, gas exploration workers have discovered in Shaanxi-Gansu-Ningxia Basin a large natural gas field with substantial potential.

According to a spokesman from the Changqing Gas Exploration Bureau, the natural gas field in the central and eastern part of the Shaanxi-Gansu-Ningxia Basin

was discovered in 1986 when they were exploring for oil in Zizhou County, Shaanxi Province. So far, in 10 Shaanxi counties, including Mizhi, Suide, Fugu, Ansai, and Zhidan, and in Otog Qianqi of Inner Mongolia Autonomous Region, 43 wells have been drilled. Only 28 of these wells were tested, and of which 24 of them each has a daily output of natural gas of 10,000 cubic meters. Twelve of these wells are high-output wells with a daily output of more than 200,000 cubic meters of unimpeded gas flow. The highest output gas well produces indications of a daily output of over 300,000 cubic meters of unimpeded gas flow.

Based on the analysis of the preliminary exploration data, it was found that within a relatively large area that spans across the four provinces (regions) of Shaanxi, Gansu, Ningxia, and Inner Mongolia, there exists a multi-strata, multi-system, sedimentary gas field. The natural gas belongs to the type of low-penetration, coal-produced gas with a well depth of 3,200 meters.

The gas is concentrated in continuous layers and this facilitates exploration. Moreover, the quality and quantity of the gas are good and present good exploration value.

Oil, Gas Prospects in Chang Jiang Basin

916B0025A Beijing JINGJI RIBAO in Chinese 29 Nov 90 p 2

[Article by staff correspondent Niu Weigong and staff reporter Gao Shufang]

[Text] Important progress has been made in the study and evaluation of the oil and gas geological conditions in an area of 1.5 million square kilometers, almost the whole Chang Jiang Basin, in 10 provinces and one municipality, namely from eastern Yunnan to Shanghai, including provinces such as Sichuan, Hunan, Hubei, Henan, Jiangsu, Zhejiang, Anhui, and the city of Shanghai. Rich oil and gas reserves were discovered.

A series of key technological achievements and results of the Seventh 5-Year Plan recently approved and passed have indicated that over 100 oil and gas closed loops (conducive to the collection and concentration of oil and gas) have been discovered, with a total area of 1,000 square kilometers, of which the upper Yangtze area in Sichuan has seen the successful drilling of three oil and gas wells, with an estimated natural gas reserve of over 100 billion cubic meters. In the Middle Yangtze Basin centered round the central Hubei area, closed loop areas of 150 square meters have been discovered and preliminarily studied and indications of the presence of natural gas have been found. In the lower Yangtze Basin area, centered around Jiangsu Province, there are strata of various oil-producing conditions and potential. The Nanjing-Nantong area has very favorable potential for oil and gas. In a series of drilled wells, indications of various types of gas and oil were found and also small oil and gas flows were found. Through a comprehensive dissection of the oil/gas geological conditions of the whole area, and through the study of the comprehensive geological pattern and regional oil/gas geological conditions, it has been proved that there is a large potential for oil and gas resources in the marine areas of the basin.

Over one-half of the world's oil and gas reserves are found in marine carbonate strata. In China, there are over 3 million square kilometers of this kind of geological strata, comprising about one-half of China's area of sedimentary rocks. In China, marine carbonate rocks have a very old geological age and are complex in structure, creating a high degree of difficulty in the exploration of oil and gas. It has been conceived as a "world class difficulty." Foreign experts have believed that the problem of getting oil from China's marine carbonate rock strata can only be solved by Chinese people themselves. The job of solving the problem falls on the Ministry of Geology and Mineral Resources. Through the hard work of the Sixth 5-Year Plan period and the hard work of the Seventh 5-Year Plan period in which "The Study on the Exploration Technology and Evaluation of Yangtze Marine Carbonate Rock Strata Oil and Gas Reserve" was launched, not only was a large reserve of natural gas and oil found, but also a new theory and a new concept in the exploration of oil and gas in marine areas. A preliminary system of concepts and theory was formed on the geology of oil and gas in the complex marine geology peculiar to China. A whole set of new methods adapted to and suitable for use in marine carbonate areas was basically formulated. New achievements in the study of the method and technology in the exploration, drilling, testing and geological experiments, of advanced standards, internationally and nationally, were obtained. It does the preparatory work for the shift to and exploration of marine areas in the exploration of the nation's oil and gas reserves.

6000MW in Installed Capacity Planned by End of Century

40100030 Beijing CHINA DAILY (Economics and Business) in English 29 Jan 91 p 2

[Article by Xu Yuanchao: "Three Nuclear Reactors Planned"]

[Excerpt] China plans to put three nuclear reactors into use in the next three years and hopes to have a nuclear power capacity of 2,100-megawatts by 1993 to satisfy the rising demand for electricity.

Development of the nation's nuclear industry will have three steps in the next decade, Jiang Xinxiong, president of the China National Nuclear Corporation (CNNC) told a national conference in Beijing on Saturday.

The first step includes the installation of a 300-megawatt reactor at the Qinshan Nuclear Power Plant in Zhejiang Province which will go into operation this year. Also as part of the first step will be the installation of a 900-megawatt reactor at the Daya Bay plant in Guangdong Province which will go into operation in 1992.

The Qinshan plant is now undergoing a comprehensive review of its quality, said Li Yingxiang, a CNNC spokesman.

"It will be the first nuclear reactor in operation in China. We are carefully spending time reviewing its quality before putting it into operation in order to guarantee 100 percent safety," he said.

Jiang Xinxiong said the second step will involve another 900-megawatt reactor at the Daya Bay plant scheduled to be in operation by 1993.

Construction of the second phase projects—a second 300-megawatt reactor and two 600-megawatt reactors—at the Qinshan plant will take place between 1993 and 1995.

China has also decided to build a nuclear station in Northeast China's Liaoning Province with two 1,000-megawatt nuclear reactors to be imported from the Soviet Union, he said.

According to the corporation, China plans to complete these nuclear power plants by the turn of the century.

The third step will take place during the Ninth Five-Year Plan (1996-2000), Jiang said, adding that the industry is expected to build a number of other nuclear power plants with a total capacity of 6,000-megawatts.

He said the nuclear industry will adhere to the open policy and promote technological exchange and trade with other countries.

The corporation will expand export nuclear technology and equipment while continuing to attract more foreign investment this year.

The corporation has signed bilateral co-operation agreements with governments and organizations from 13 nations including the United States, Germany, France, Italy and Japan. It has technological exchanges and trade relations with over 40 countries.

Jiang said the industry will concentrate its effort on the construction of nuclear power plants, production of nuclear fuel and development of isotope and irradiation technology.

[passage omitted]

Low Temperature Heat-Supply Nuclear Reactor Said 'State of the Art'

916B0008A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 20 Sep 90 p 1

[Article by Wang Hanling [3769 5060 2651], Shi Jianping [4258 1696 1627], and Cheng Xiaoshuang [4453 1420 3642]: "International Experts Consider Qinghua University's Successful Operation of 5 Megawatt Reactor of World Significance"]

[Text] China's peaceful use of nuclear power entered a new phase when Qinghua University completed the construction and put into operation an experimental 5 megawatt, low temperature, heat-supply nuclear reactor with conventionally safe pressure hull. On 17 September, the reactor passed its technical certification and acceptance test. The world's largest 200 megawatt, low temperature reactor for industrial heat supply experiment and demonstration will soon be under construction at the Chilin Chemical Company. This was approved on 18 September. The International Nuclear Energy Organization, West German, and Swiss experts agree that China is at a leading position in the low temperature, heat-supply reactor activity and that its successful 5 megawatt reactor operation is of world significance. Because of its safety features and economic value, it has become a focal point of attention internationally. Although China's efforts in this research had a late start, real progress was made when the research was included among the key research projects in the Sixth and Seventh 5-Year Plans. The successful operation of this reactor clearly indicates that China is among the world's leading low temperature heat-supply reactor technology nations.

According to our understanding, China developed and researched this 5 megawatt reactor in complete independence. This reactor is China's first adoption of a unified body construction with autostabilized pressure, new hydraulic linkage control rods, non-dynamic surplus heat dissipation system, and double pressure hull, all new and innovative features.

This has pioneered a new path in the peaceful use of nuclear power, and has created a solid foundation for

further nuclear power heat supply development. Many departments of Qinghua University have made outstanding technical achievements in this project.

During this period, they were also successful in upscaling the design for a larger industrial reactor of 200 megawatt power. This is planned to be completed by 1995. When it is put into operation, it will replace coal-burning boilers and provide heat-supply needs for thousands of households and save 300,000 tons of coal each year. Economic analysis confirms that the total cost for low temperature, heat supply nuclear reactor systems is lower than that for coal-burning heat-supply systems.

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